UNIVERSITAT POLITÈCNICA DE CATALUNYA
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Industrial i Aeronàutica de Terrassa

STUDY AND SIMULATION OF CUBESATS COMMUNICATION SYSTEMS FOR ISARA MISSION

ANNEX

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STUDIES: GRAU EN ENGINYERIA EN VEHICLES AEROESPACIALS

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CONTENTS SUMMARY

This document works as a complement to the explanations of CHAPTER 4 from the REPORT of this study. It is exclusively illustrative and contains all the graphics and images necessaries to understand the performance of the ISIS UHF antenna during its operation in ISARA mission.

It is divided in two main sections:

A. SOFTWARE SIMULATIONS
B. ISIS WEBSITE RADIATION PATTERNS

In section A, it can be found all the results of the CST Microwave Studio simulations. It has been studied 3 main configuration cases:

1. Isolated UHF antenna
2. 3U UHF antenna
3. ISARA UHF antenna

The antenna studied is made up by four monopoles of two different longitudes. For this reason, for each configuration case it has been studied every monopole separately and, finally, all together. As they are sized in twos, it was just required to simulate two of them (P1 = P3 and P2 = P4). Totally, it has been made 10 different simulations. The obtained graphics in each simulation are:

a) S – Parameters
   - Return loss
   - Insertion loss (if needed)
b) Radiation Pattern
   - 3D Directivity pattern
   - Directivity polar diagram
   - 3D Realized Gain
   - Gain vs frequency range
c) Efficiency vs frequency range
d) Electric field
e) Magnetic field

On the other hand, in section B, it is showed the radiation patterns facilitated by *Innovative Solutions In Space* Company on their website, as useful information about the UHF antenna performance. There were only for 3U UHF configuration with monopole, dipole and turnstile cases.

A. SOFTWARE SIMULATIONS

A.1 Isolated UHF antenna

A.1.1 Monopole P1

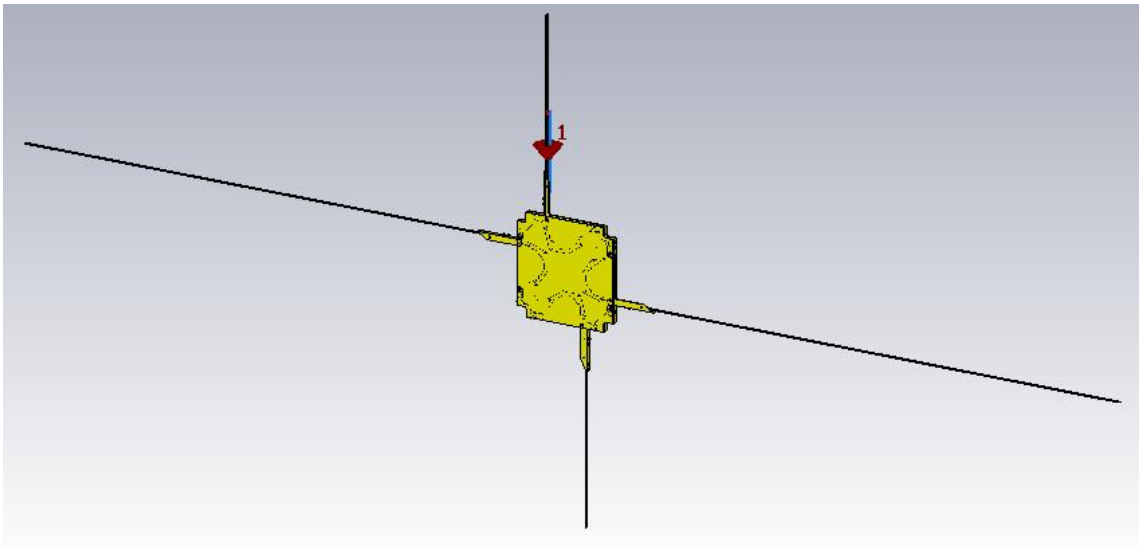

Figure 1. A1-P1. ISIS antenna CAD model.

A.1.1.1 Scattering Parameters (S – Parameters)

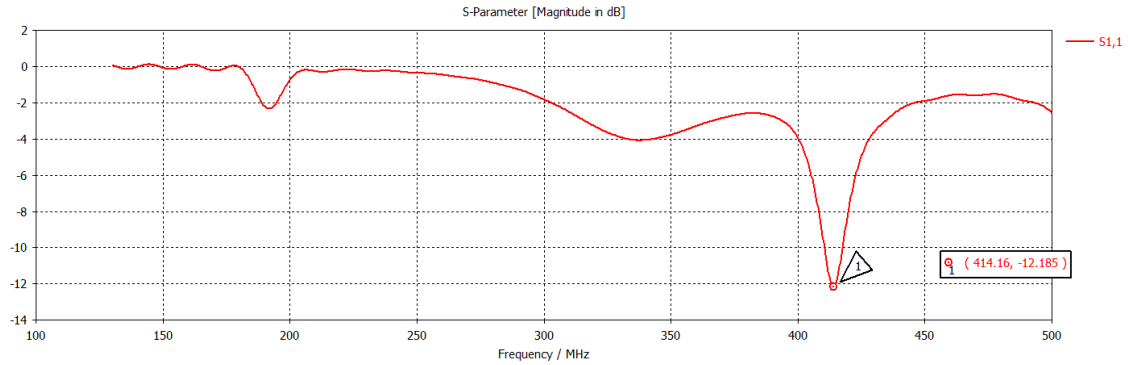

Figure 2. A1-P1. Return loss.

A.1.1.2 Radiation Pattern

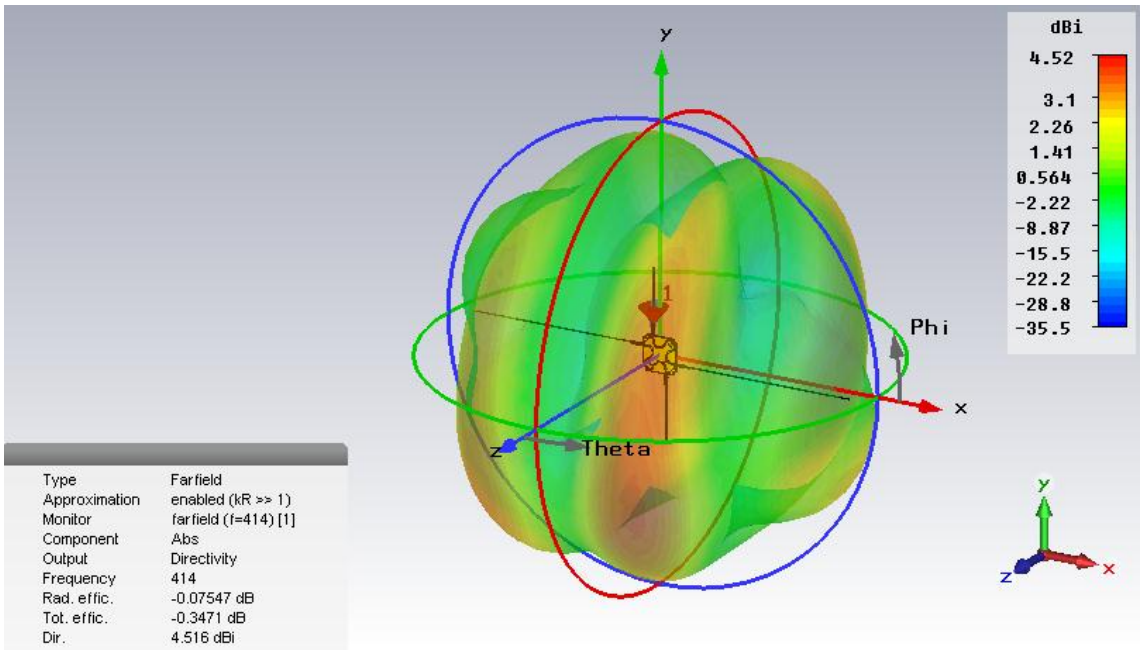

Figure 3. A1-P1. 3D Directivity Pattern (414 MHz).

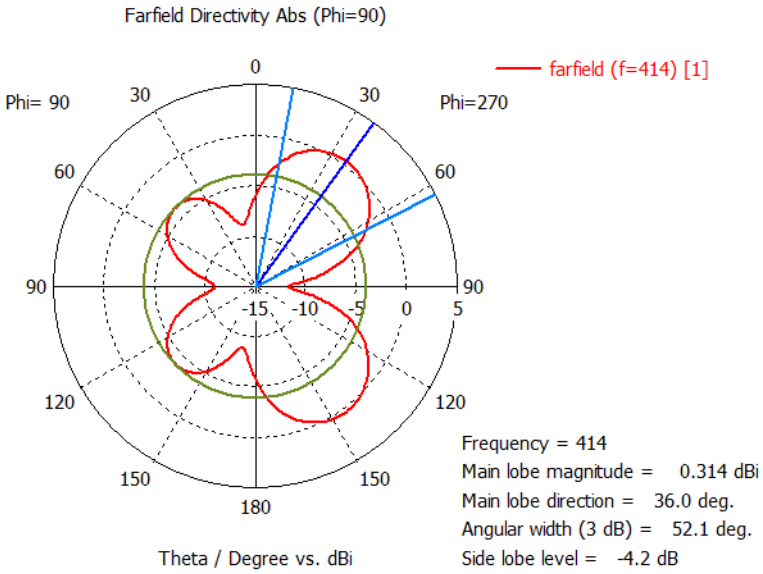

Figure 4. A1-P1. Directivity Polar Diagram (414 MHz).

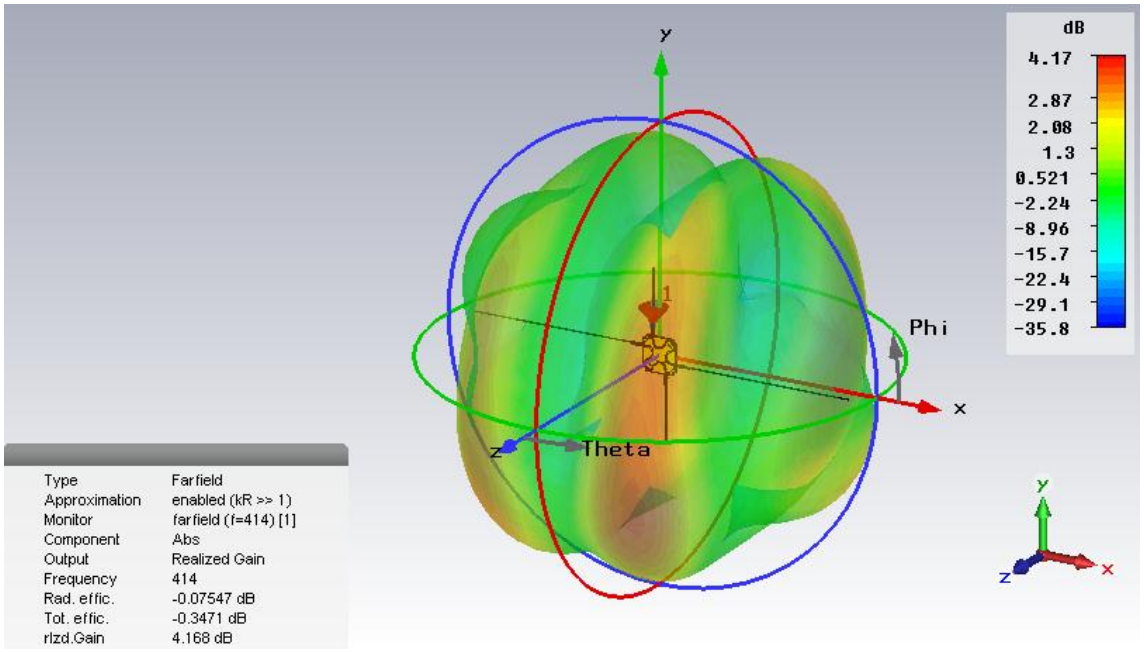

Figure 5. A1-P1. 3D Realized Gain Pattern (414 MHz).

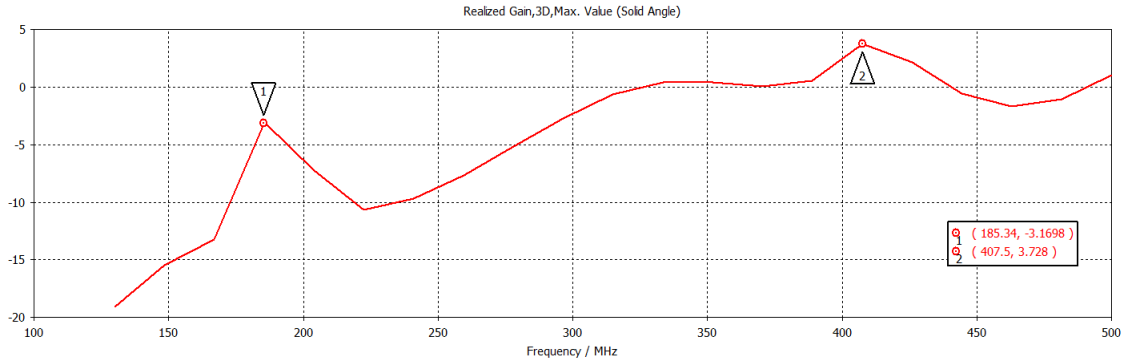

Figure 6. A1-P1. Realized Gain dependent on range frequency 130-500 MHz.

A.1.1.3 Efficiency

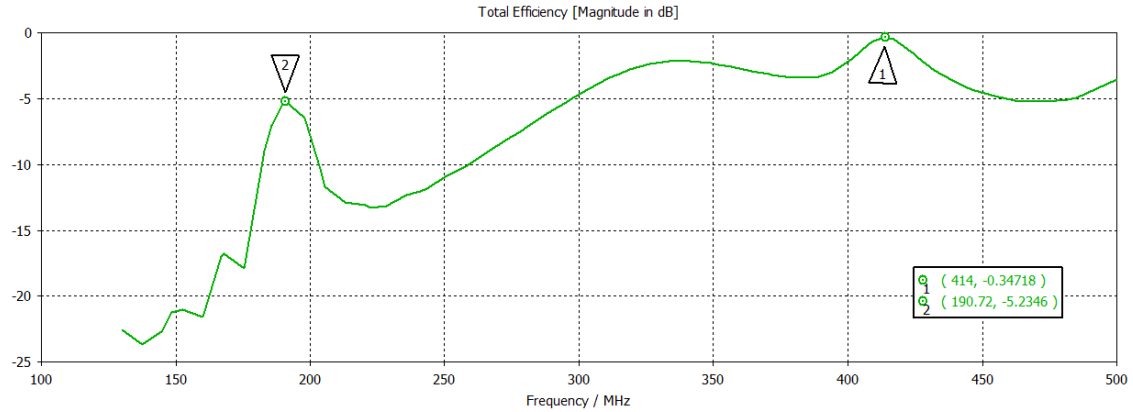

Figure 7. A1-P1. Antenna efficiency dependent on range frequency 130-500 MHz.

A.1.1.4 Electric field

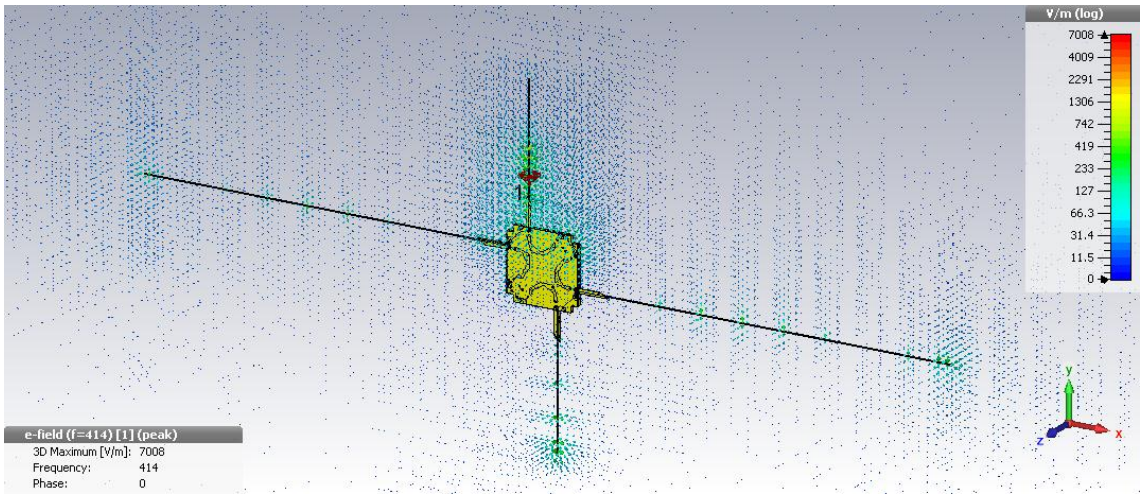

Figure 8. A1-P1. Electric field (414 MHz).

A.1.1.5 Magnetic field

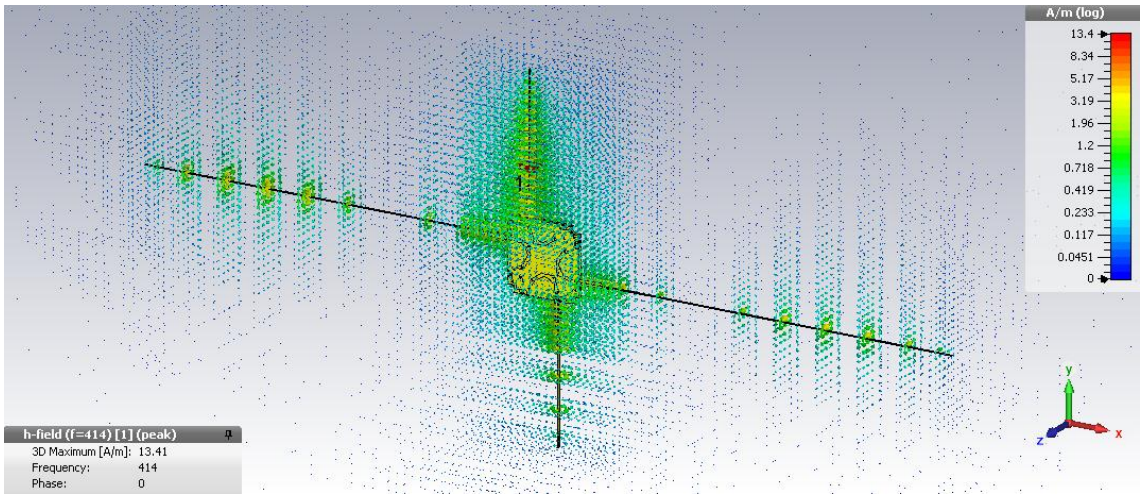

Figure 9. A1-P1. Magnetic field (414 MHz).

A.1.2 Monopole P2

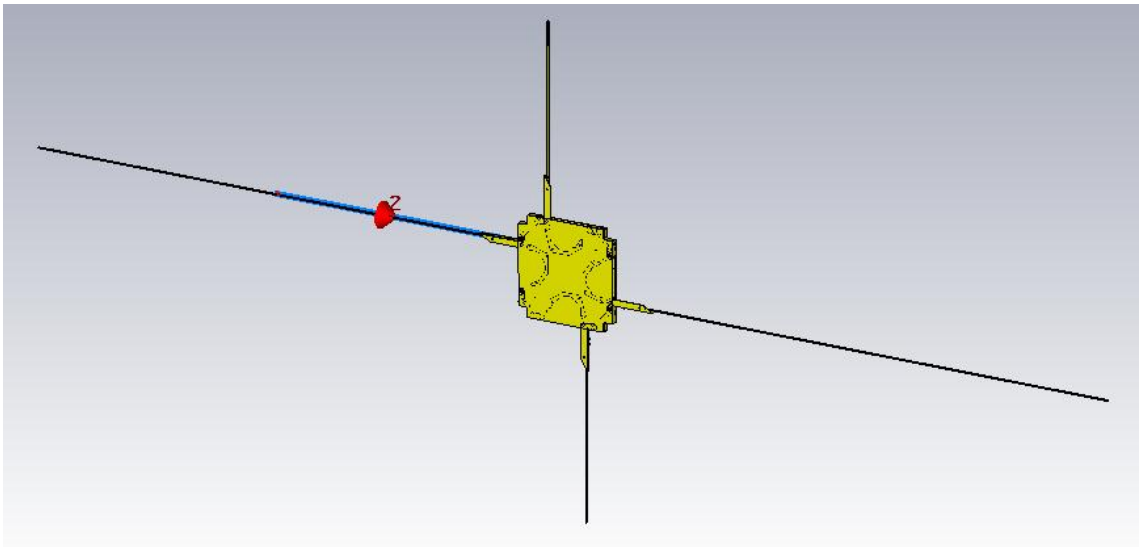

Figure 10. A1-P2. ISIS antenna CAD model.

A.1.2.1 Scattering Parameters (S – Parameters)

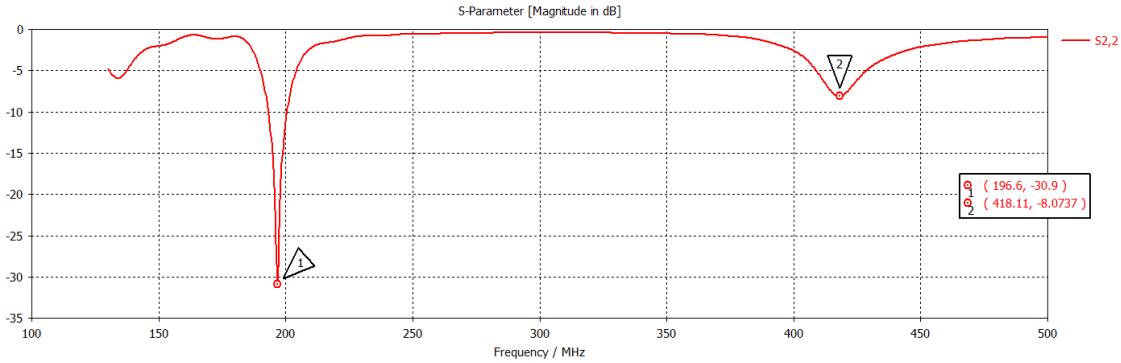

Figure 11. A1-P2. Return loss.

A.1.2.2 Radiation Pattern

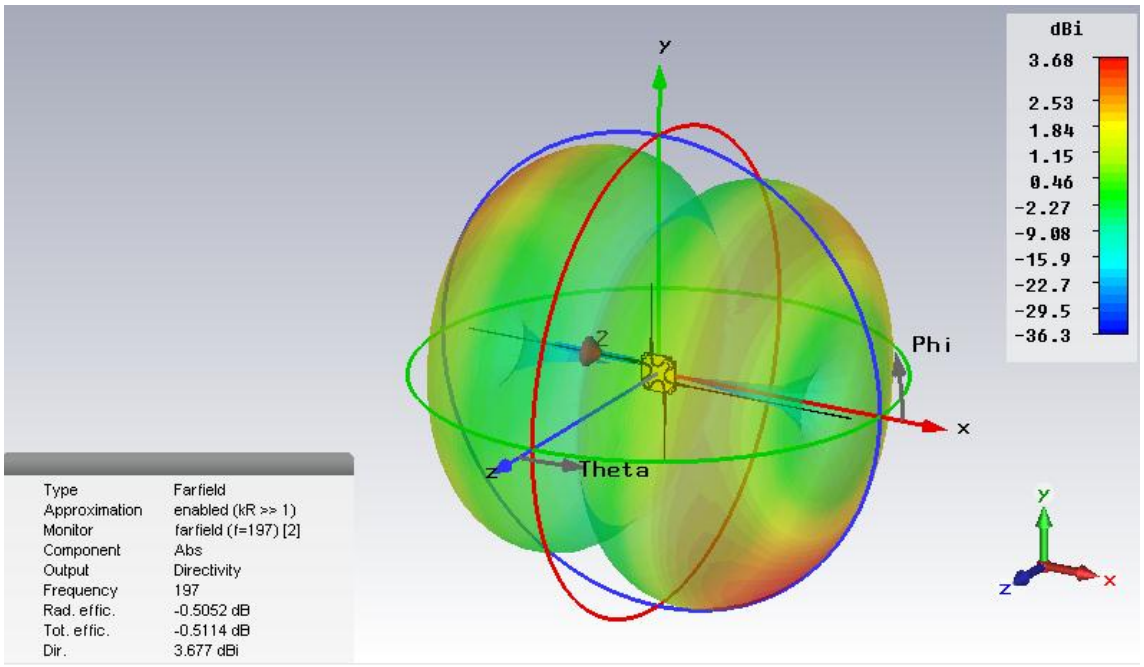

Figure 12. A1-P2. 3D Directivity Pattern (197 MHz).

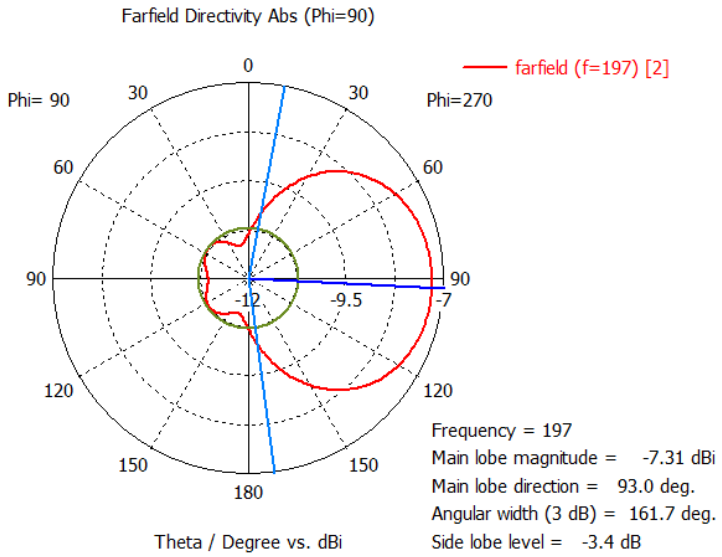

Figure 13. A1-P2. Directivity Polar Diagram (197 MHz).

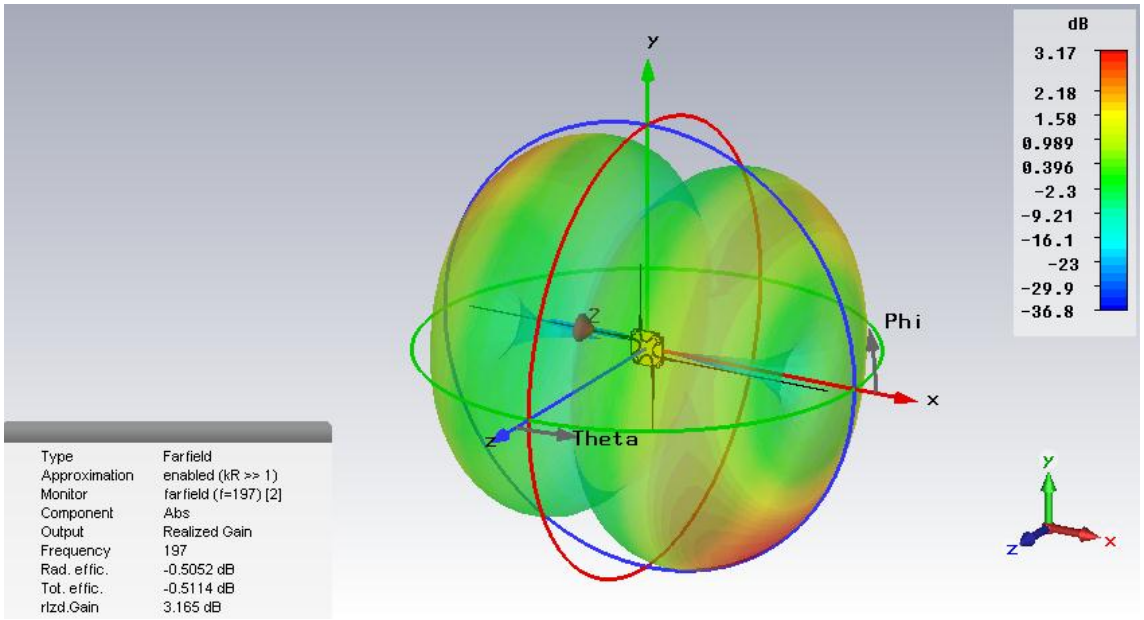

Figure 14. A1-P2. 3D Realized Gain Pattern (197 MHz).

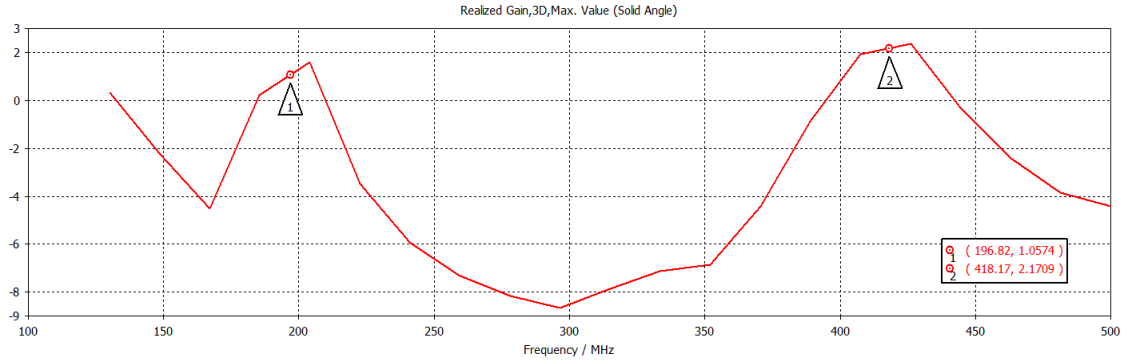

Figure 15. A1-P2. Realized Gain dependent on range frequency 130-500 MHz.

A.1.2.3 Efficiency

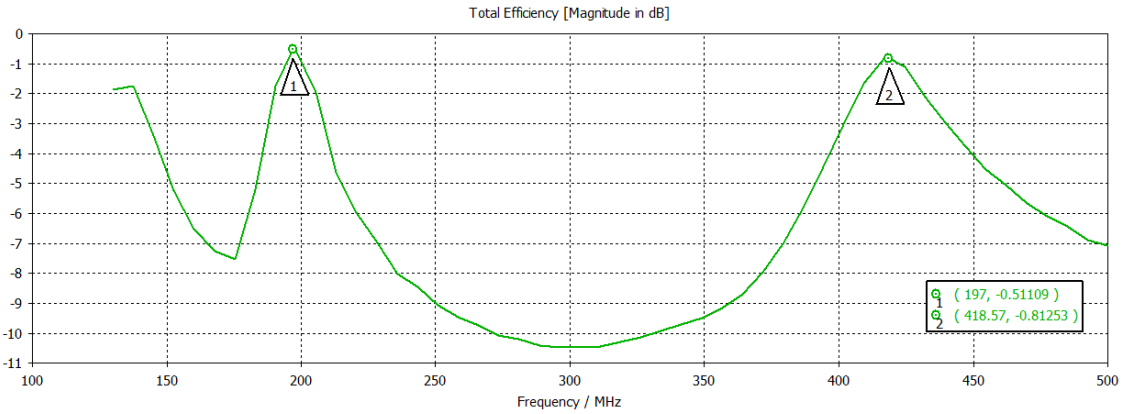

Figure 16. A1-P2. Antenna efficiency dependent on range frequency 130-500 MHz.

A.1.2.4 Electric field

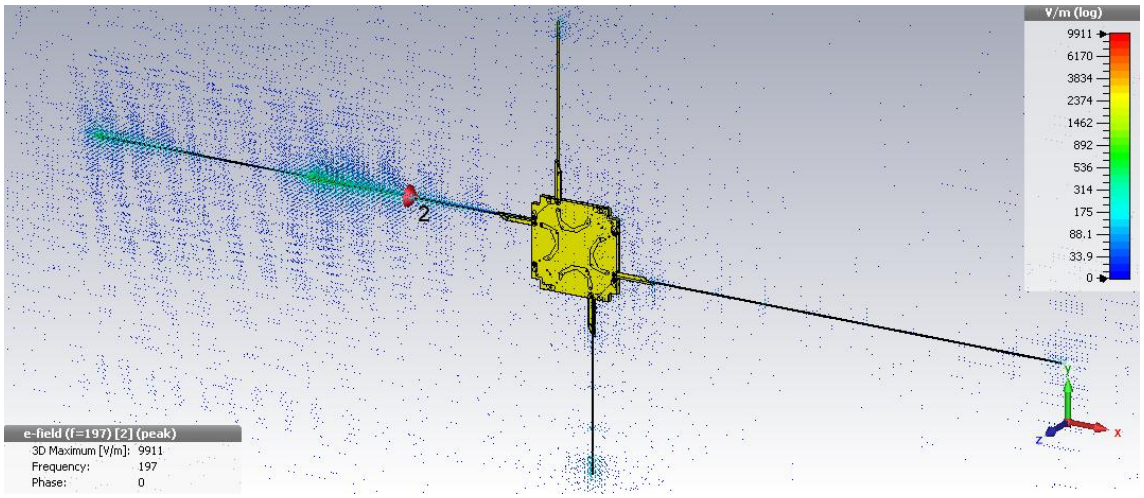

Figure 17. A1-P2. Electric field (197 MHz).

A.1.2.5 Magnetic field

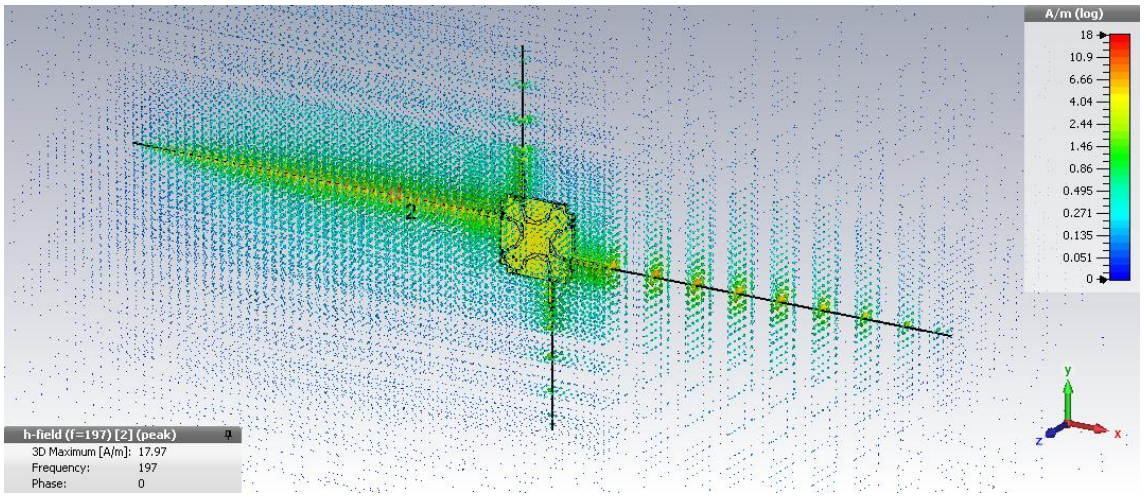

Figure 18. A1-P2. Magnetic field (197 MHz).

A.1.3 Turnstile: All Ports

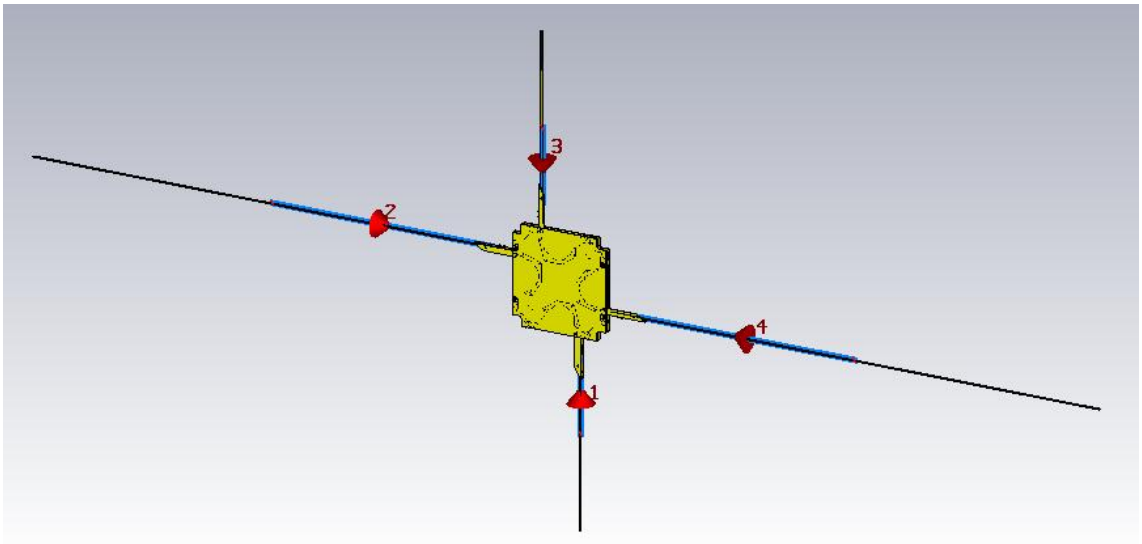

Figure 19. A1-Turnstile. ISIS antenna CAD model.

A.1.3.1 Scattering Parameters (S – Parameters)

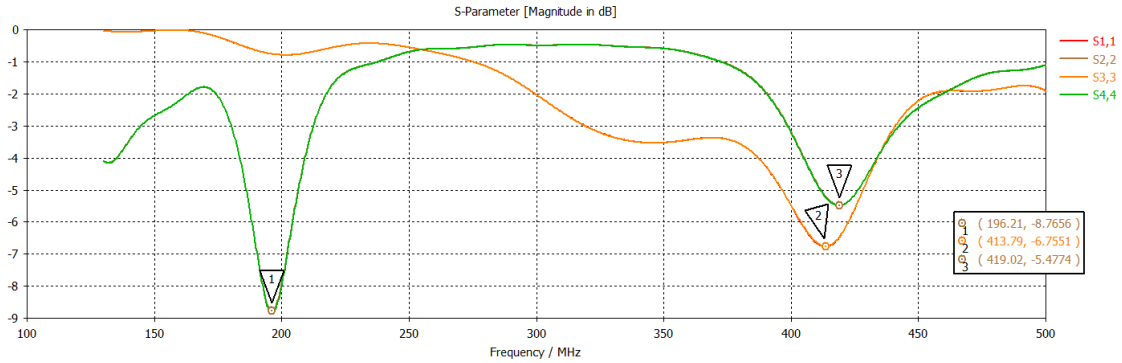

Figure 20. A1-Turnstile. Return loss.

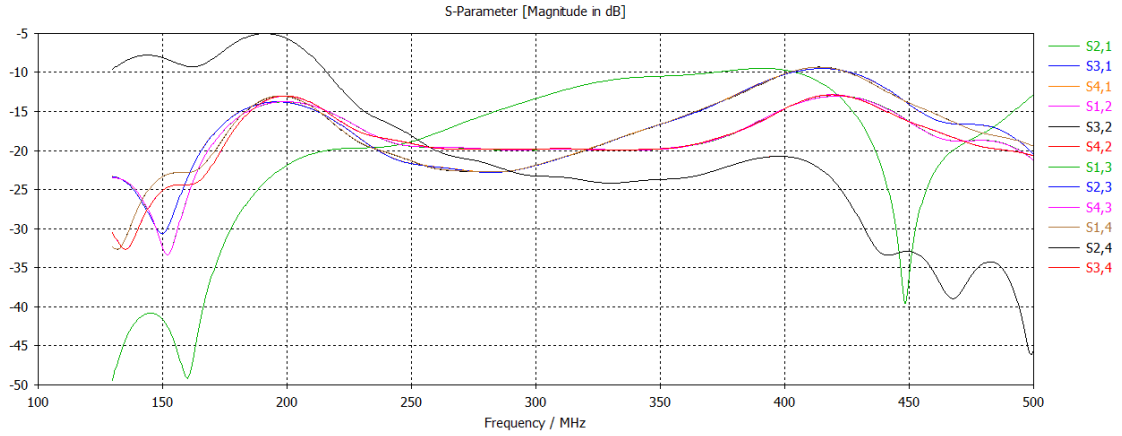

Figure 21. A1-Turnstile. Insertion loss.

A.1.3.2 Radiation Pattern

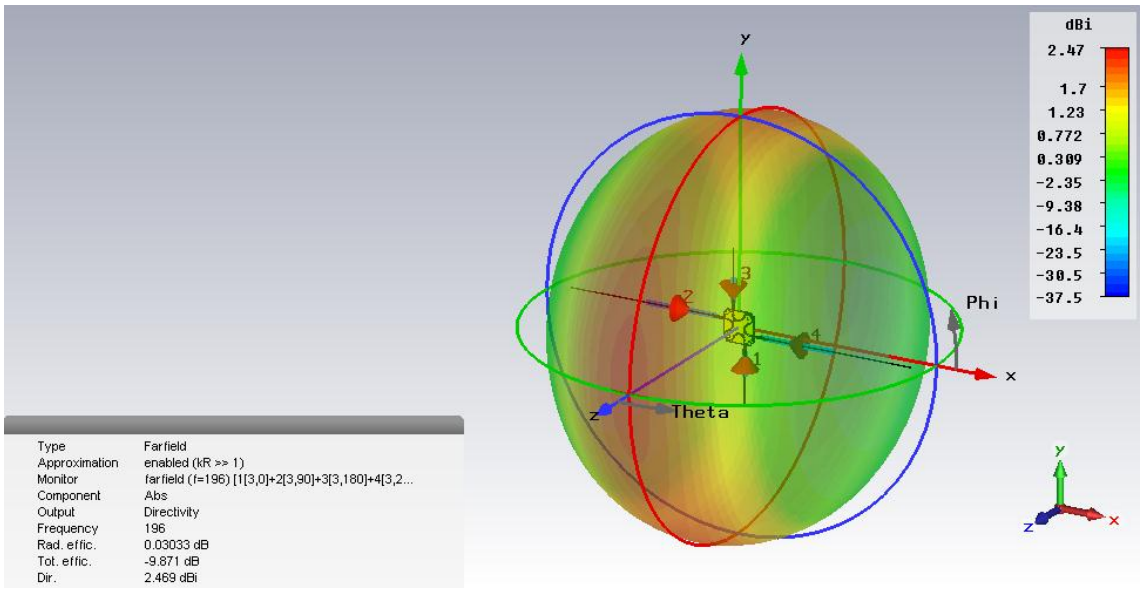

Figure 22. A1-Turnstile. 3D Directivity Pattern (196 MHz).

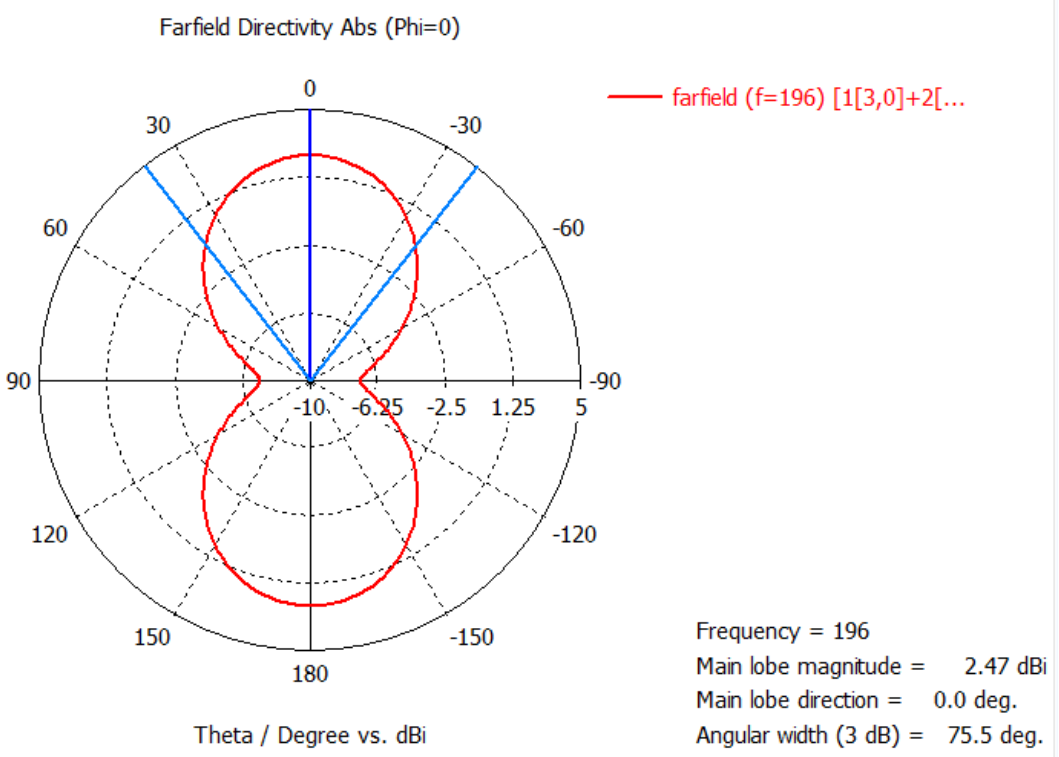

Figure 23. A1-Turnstile. Directivity Polar Diagram (196 MHz).

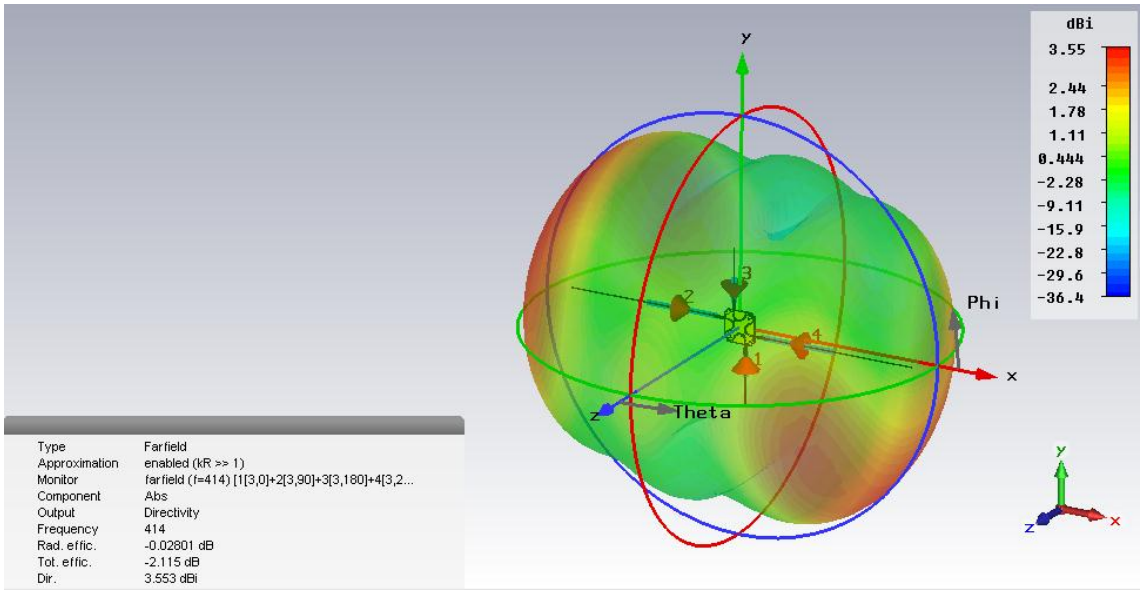

Figure 24. A1-Turnstile. 3D Directivity Pattern (414 MHz).

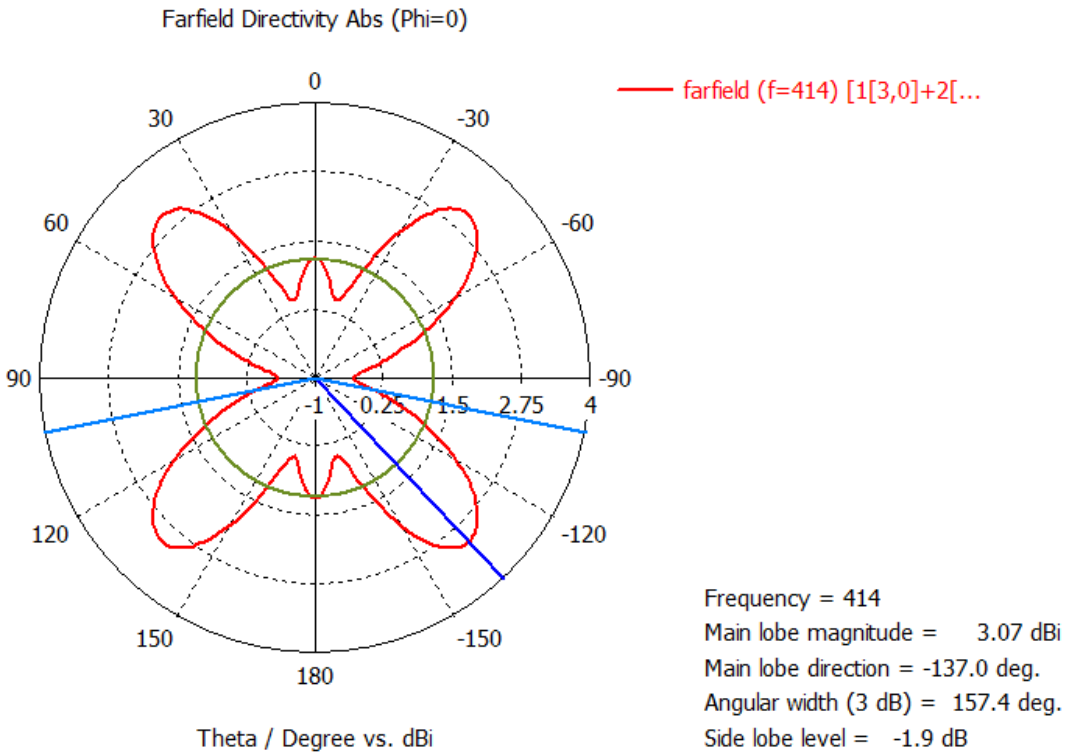

Figure 25. A1-Turnstile. Directivity Polar Diagram (414 MHz).

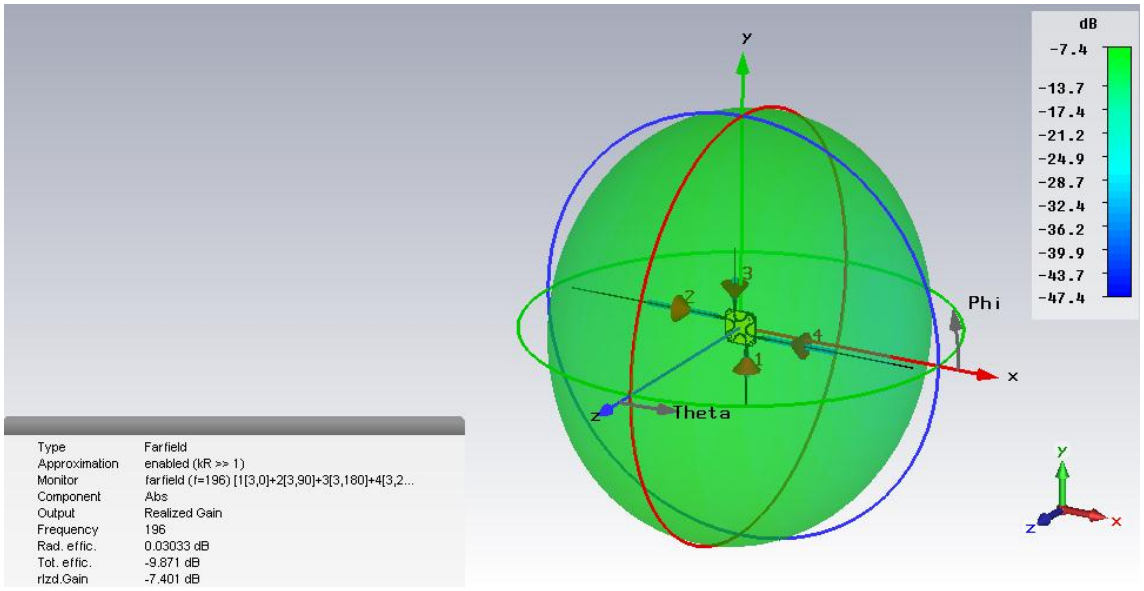

Figure 26. A1-Turnstile. 3D Realized Gain Pattern (196 MHz).

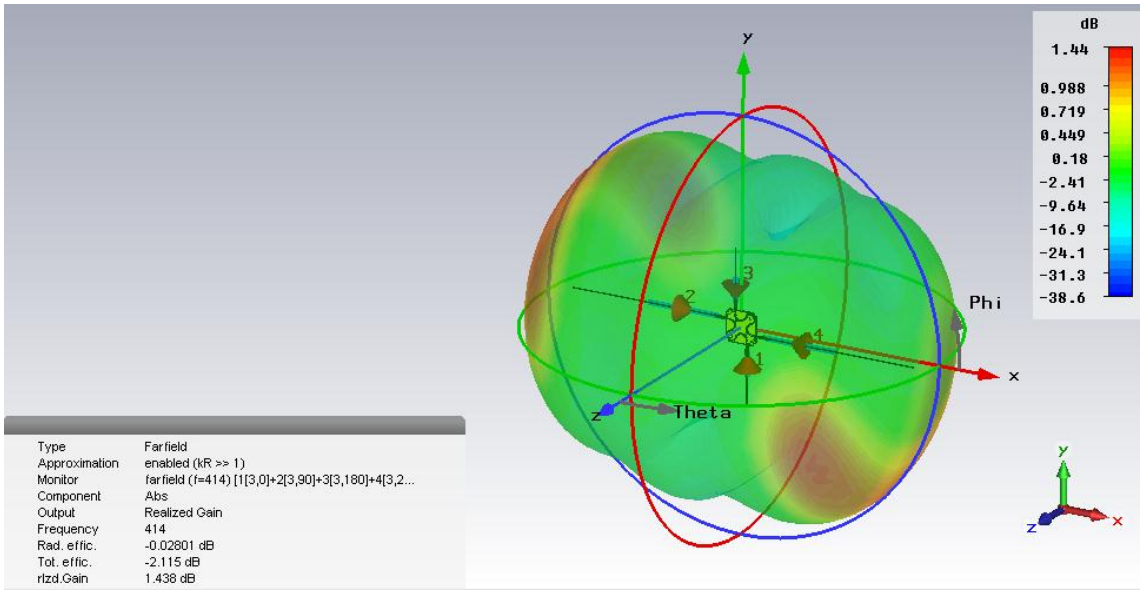

Figure 27. A1-Turnstile. 3D Realized Gain Pattern (414 MHz).

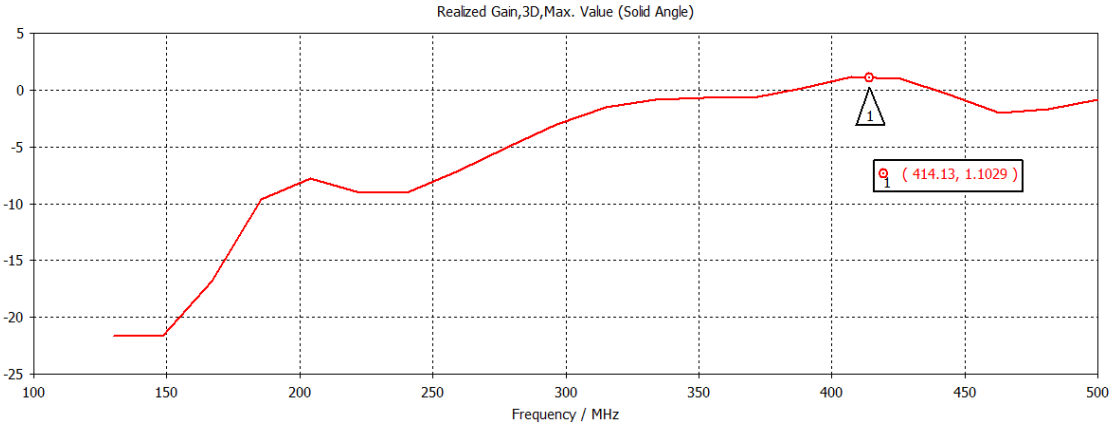

Figure 28. A1-Turnstile. Realized Gain dependent on range frequency 130-500 MHz. P1 and P3.

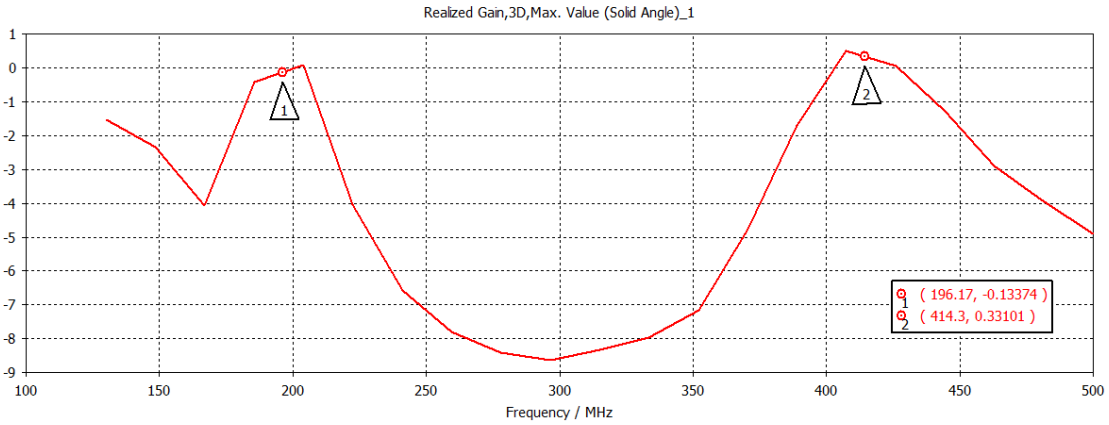

Figure 29. A1-Turnstile. Realized Gain dependent on range frequency 130-500 MHz. P2 and P4.

A.1.3.3 Efficiency

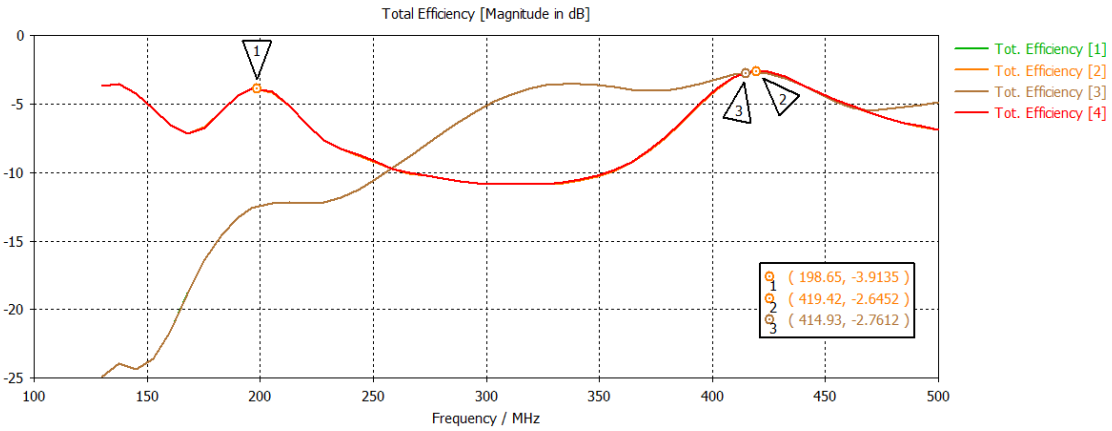

Figure 30. A1-Turnstile. Antenna efficiency dependent on range frequency 130-500 MHz.

A.1.3.4 Electric field

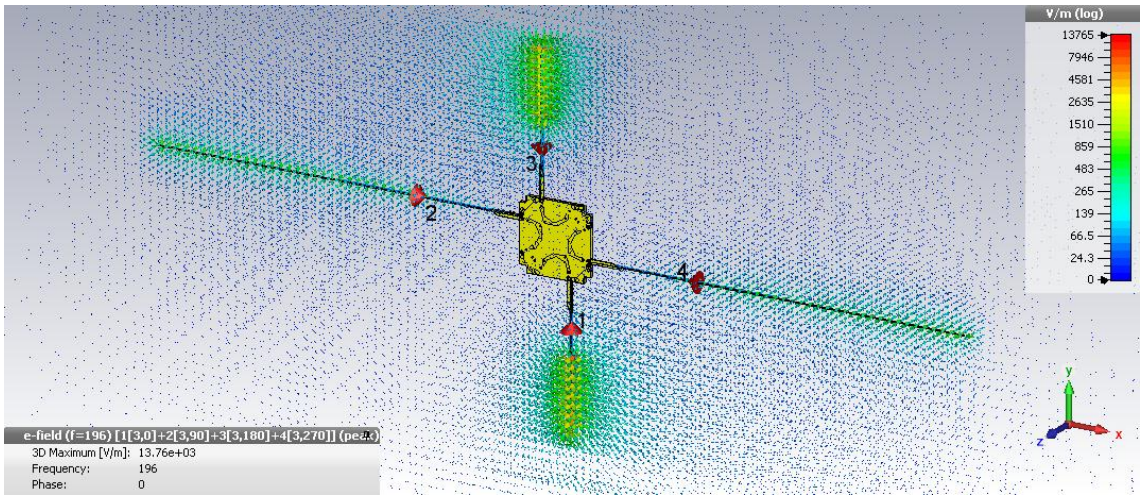

Figure 31. A1-Turnstile. Electric field (196 MHz).

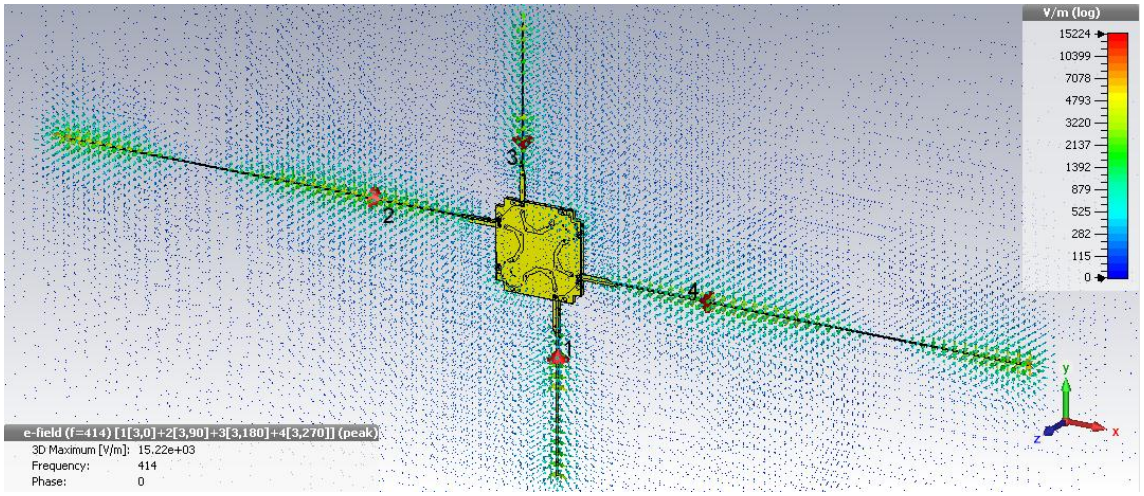

Figure 32. A1-Turnstile. Electric field (414 MHz).

A.1.3.5 Magnetic field

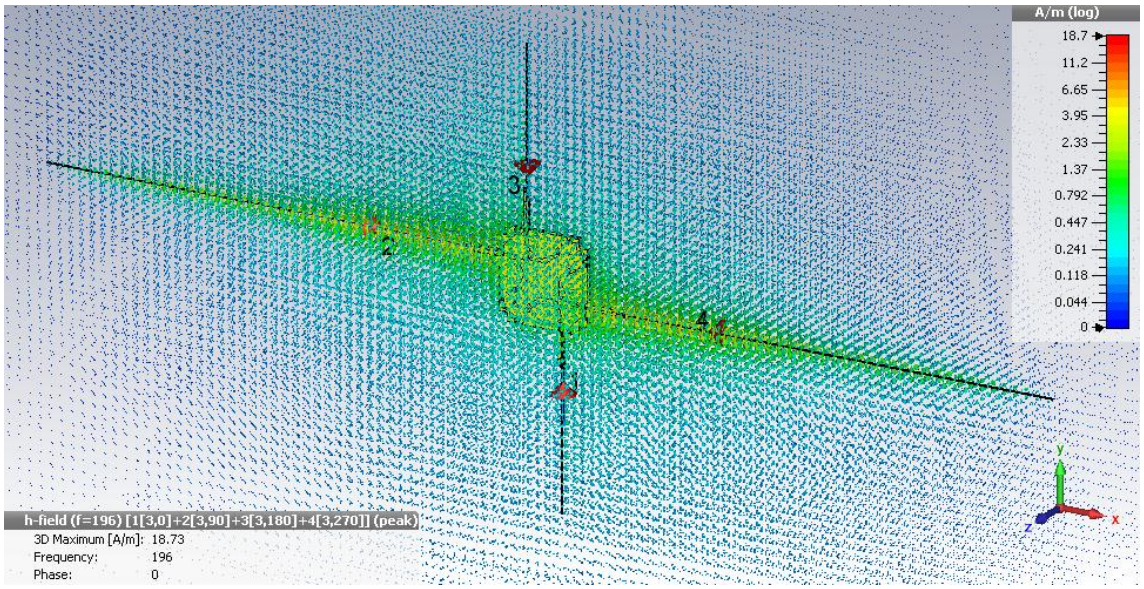

Figure 33. A1-Turnstile. Magnetic field (196 MHz).

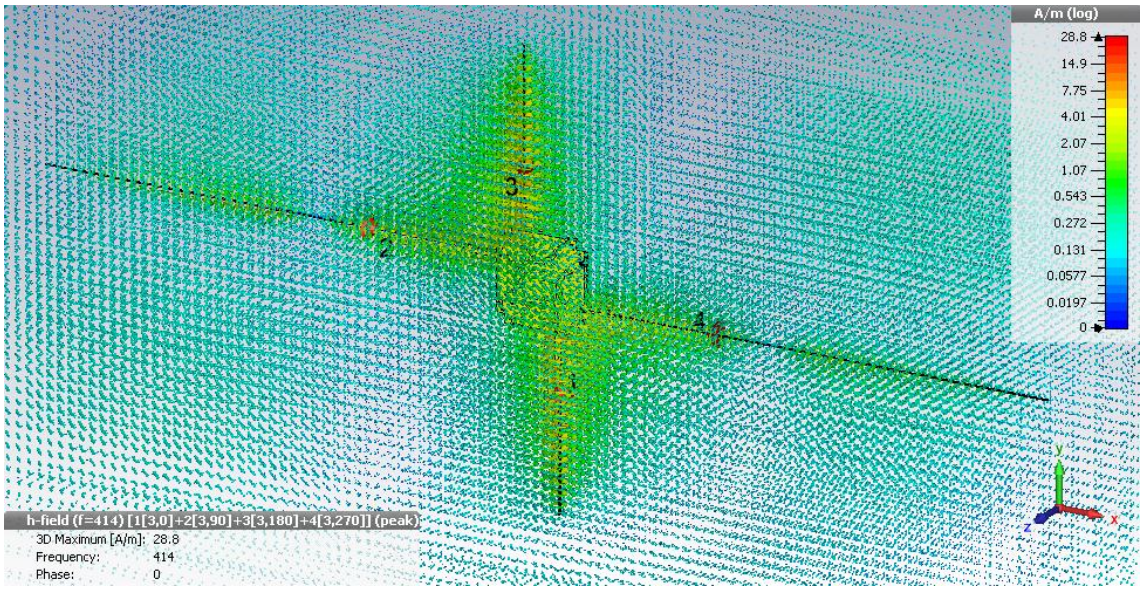

Figure 34. A1-Turnstile.Magnetic field (414 MHz).

A.2 3U UHF antenna

A.2.1 Monopole P1

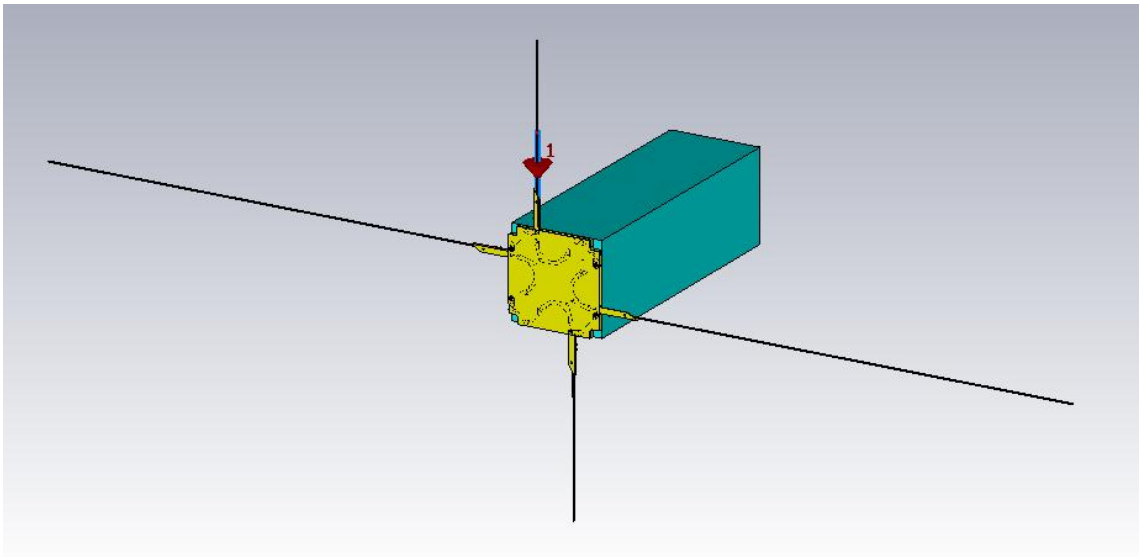

Figure 35. A2-P1. 3U UHF antenna CAD model.

A.2.1.1 Scattering Parameters (S – Parameters)

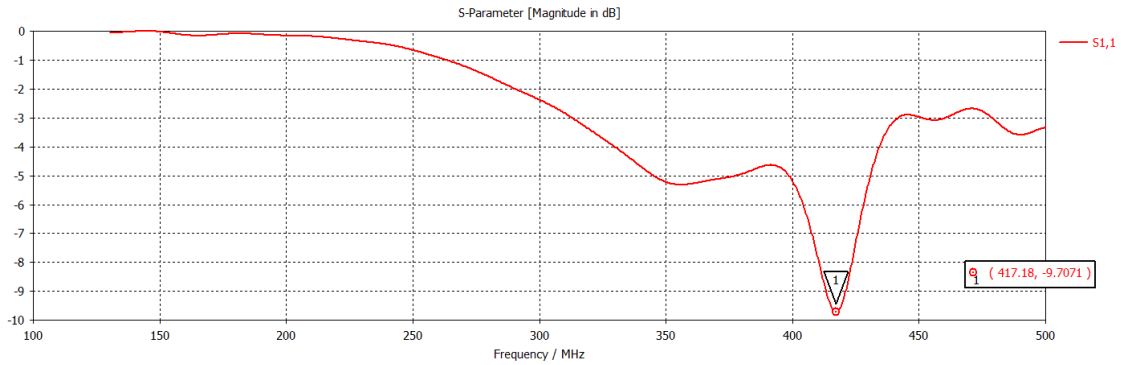

Figure 36. A2-P1. Return loss.

A.2.1.2 Radiation Pattern

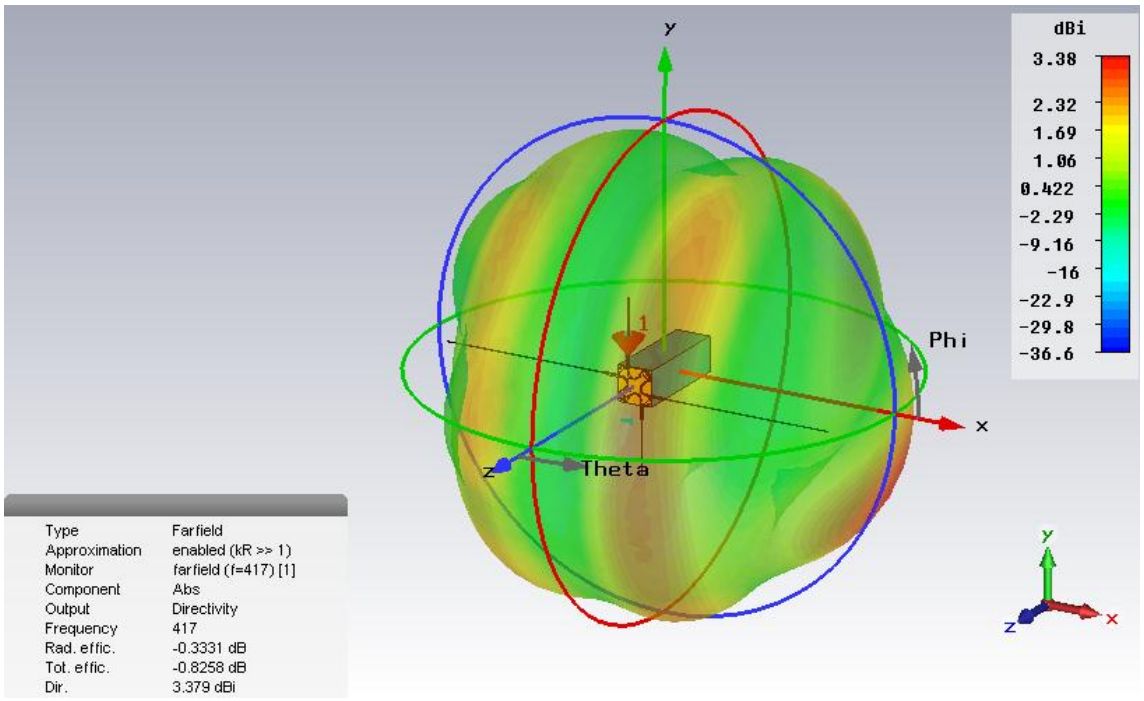

Figure 37. A2-P1. 3D Directivity Pattern (417 MHz).

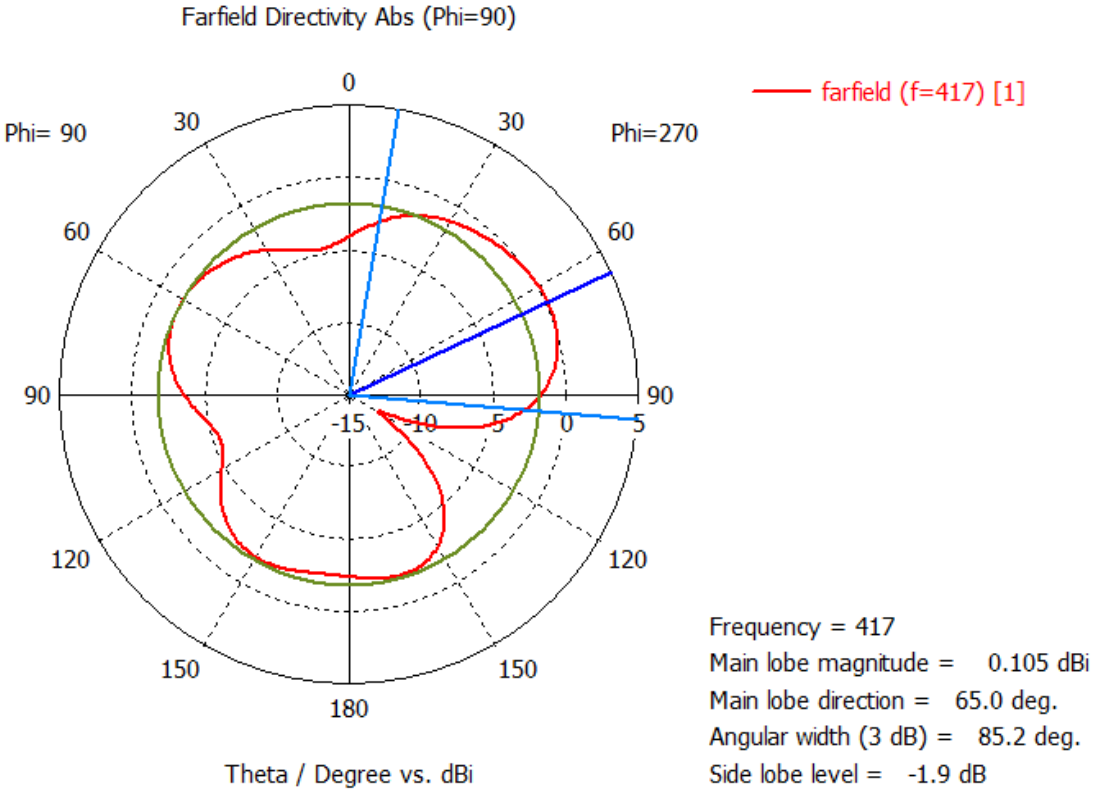

Figure 38. A2-P1. Directivity Polar Diagram (417 MHz).

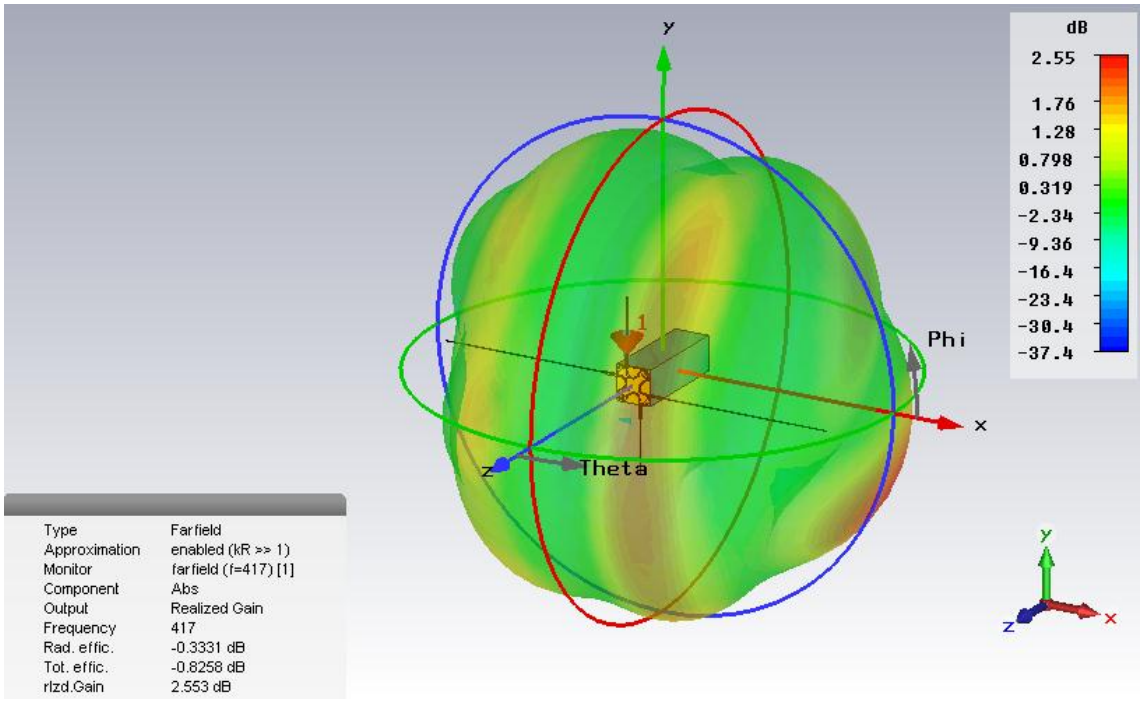

Figure 39. A2-P1. 3D Realized Gain Pattern (417 MHz).

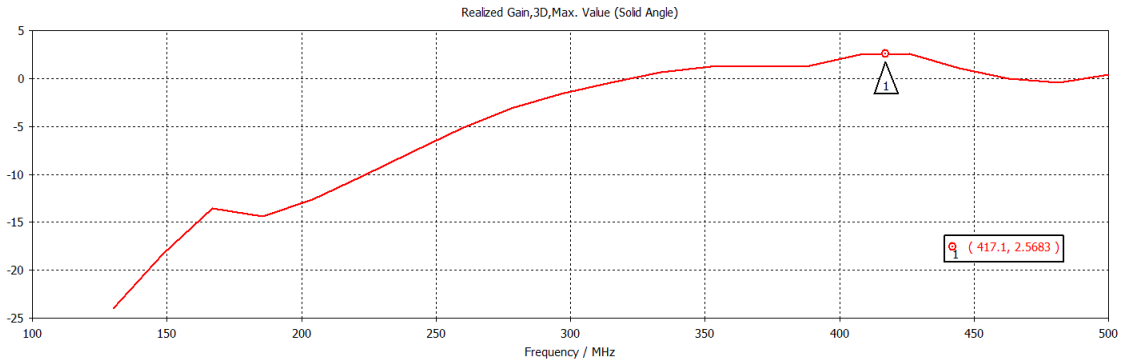

Figure 40. A2-P1. Realized Gain dependent on range frequency 130-500 MHz.

A.2.1.3 Efficiency

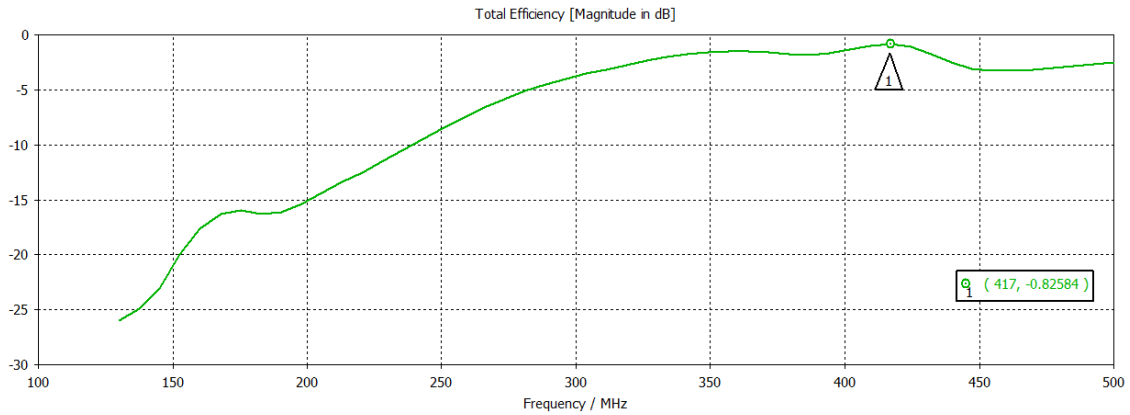

Figure 41. A2-P1. Antenna efficiency dependent on range frequency 130-500 MHz.

A.2.1.4 Electric field

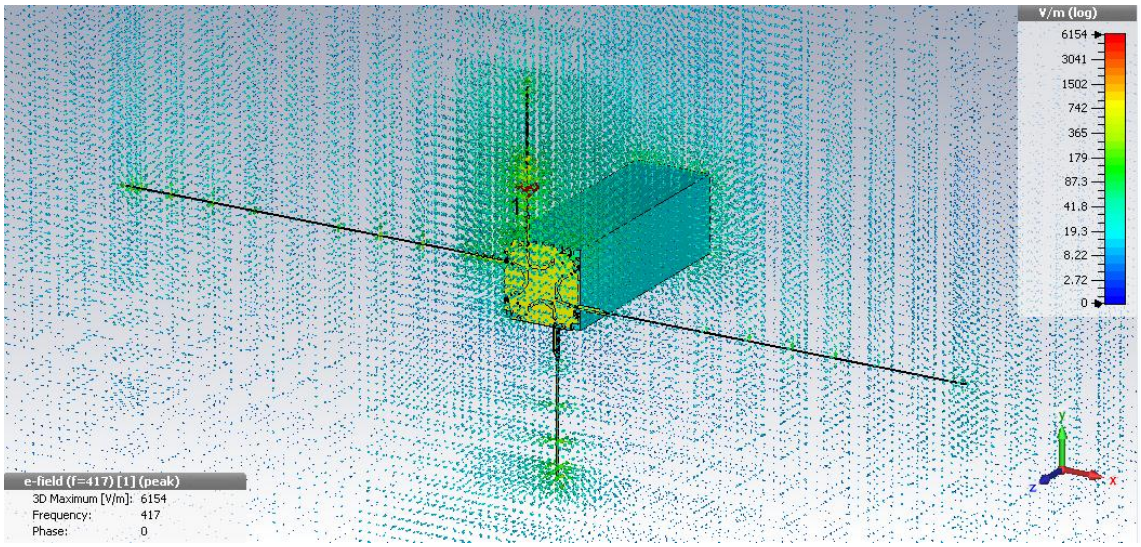

Figure 42. A2-P1. Electric field (417 MHz).

A.2.1.5 Magnetic field

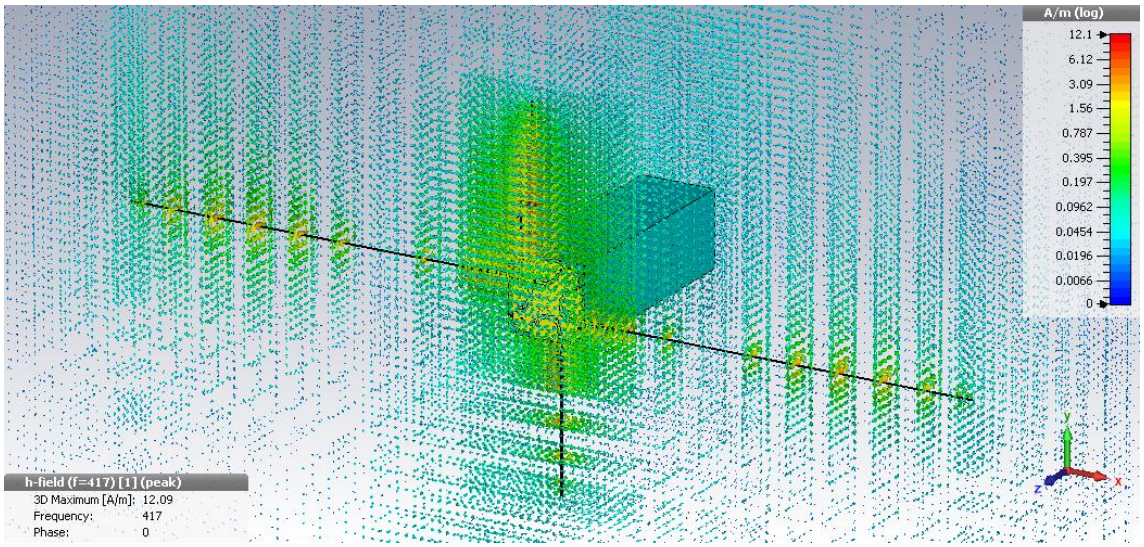

Figure 43. A2-P1. Magnetic field (417 MHz).

A.2.2 Monopole P2

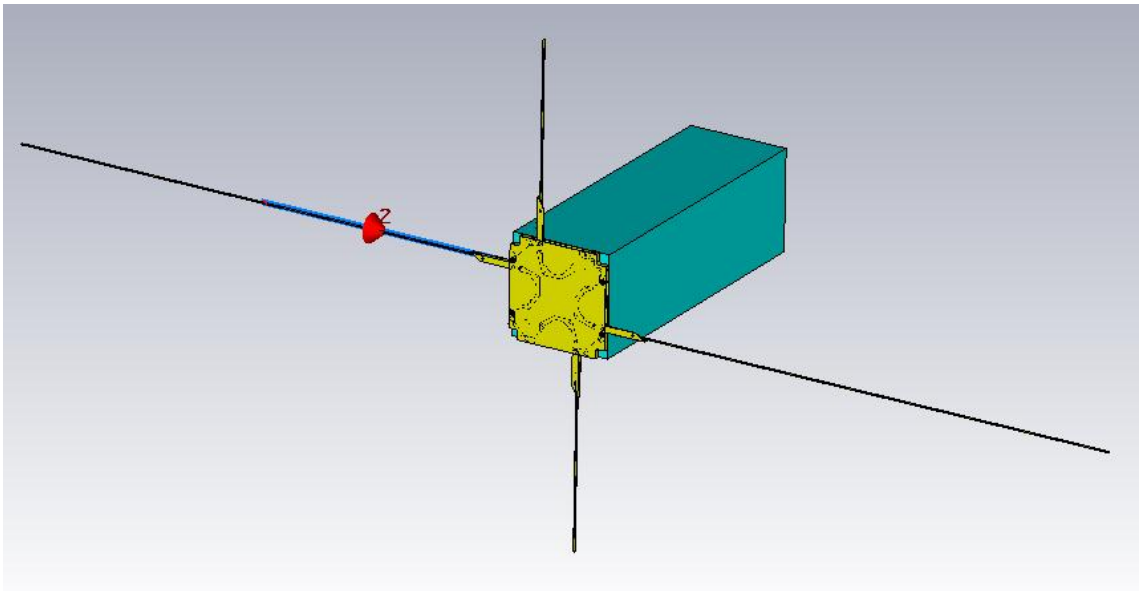

Figure 44. A2-P2. 3U UHF antenna CAD model.

A.2.2.1 Scattering Parameters (S – Parameters)

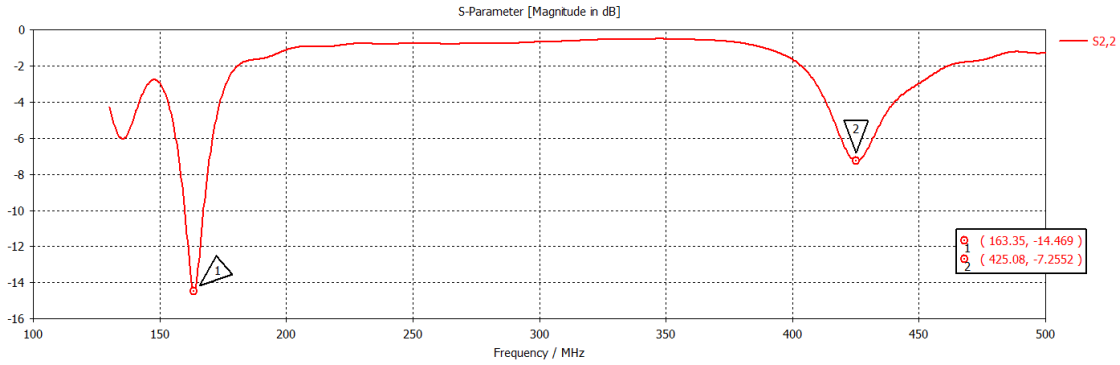

Figure 45. A2-P2. Return loss.

A.2.2.2 Radiation Pattern

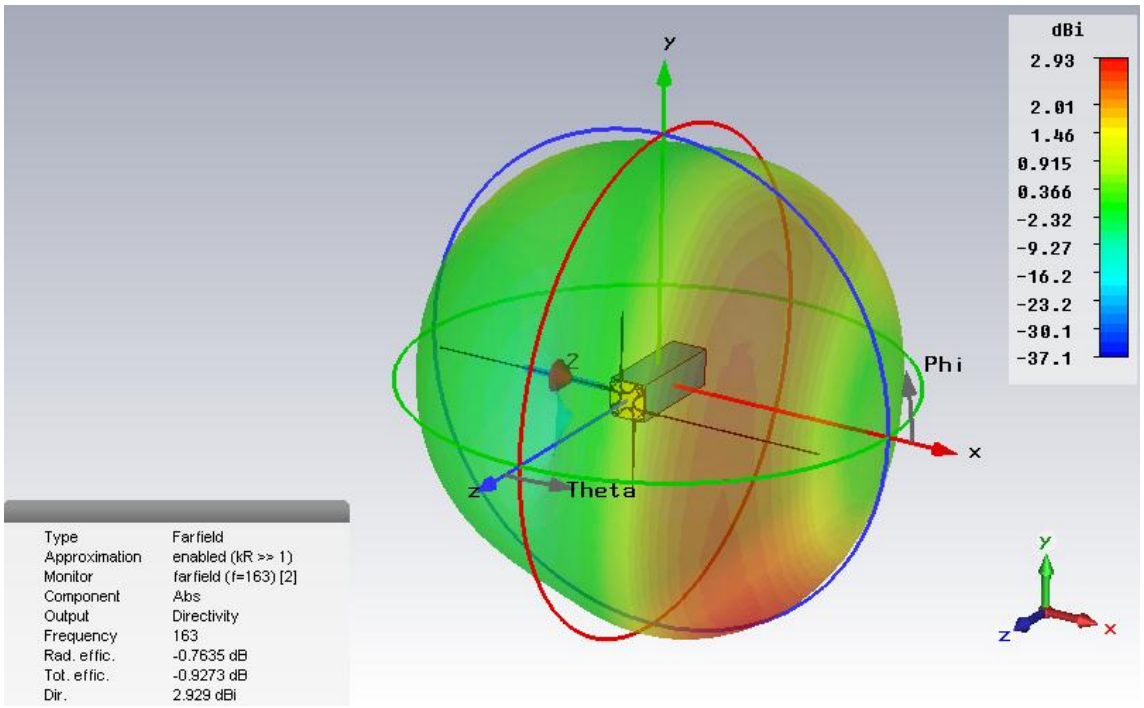

Figure 46. A2-P2. 3D Directivity Pattern (163 MHz).

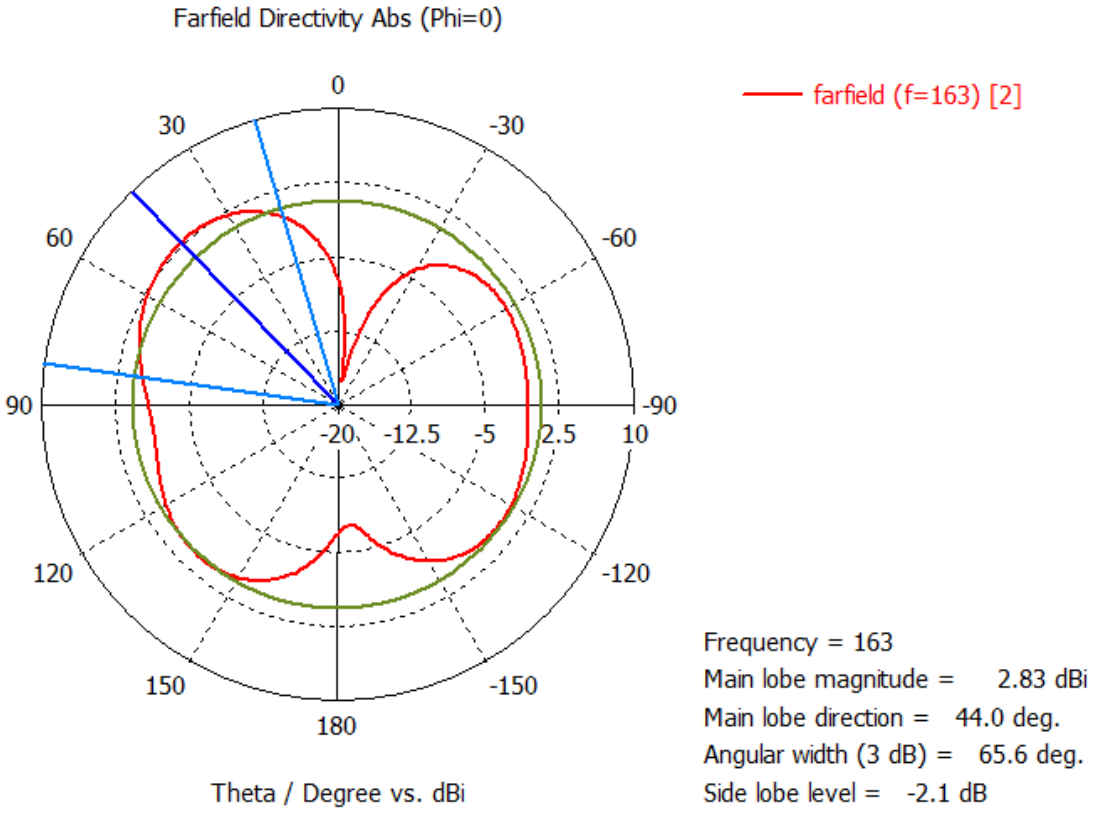

Figure 47. A2-P2. Directivity Polar Diagram (163 MHz).

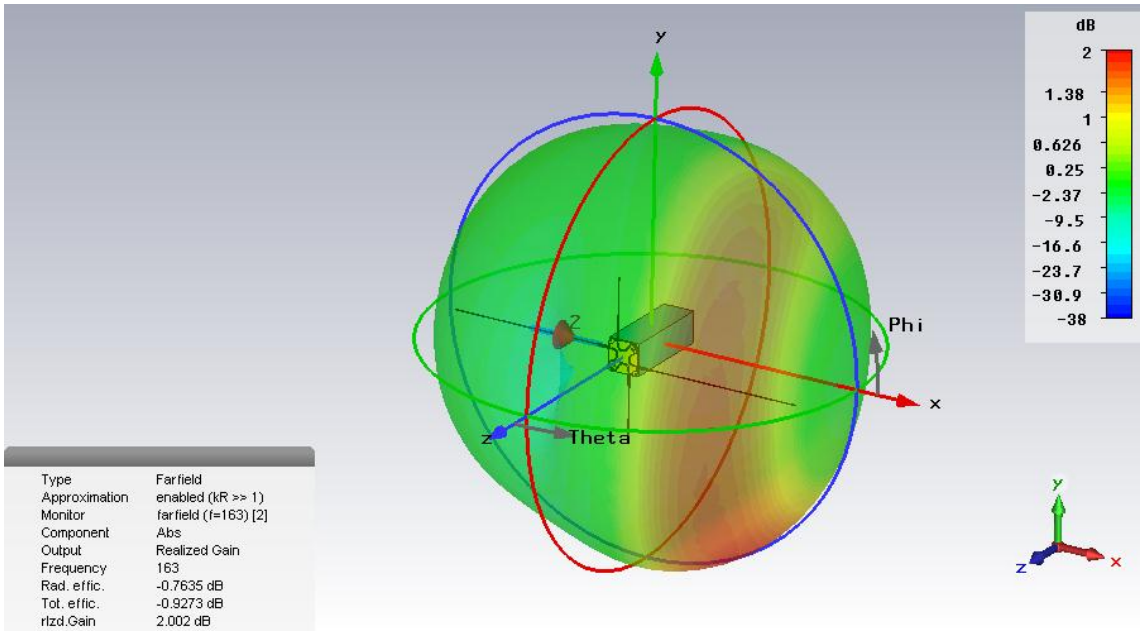

Figure 48. A2-P2. 3D Realized Gain Pattern (163 MHz).

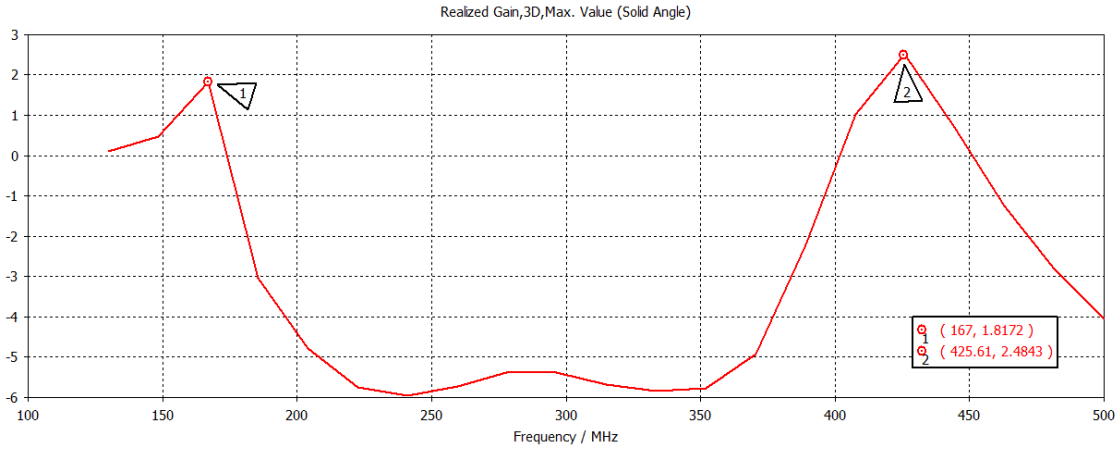

Figure 49. A2-P2. Realized Gain dependent on range frequency 130-500 MHz.

A.2.2.3 Efficiency

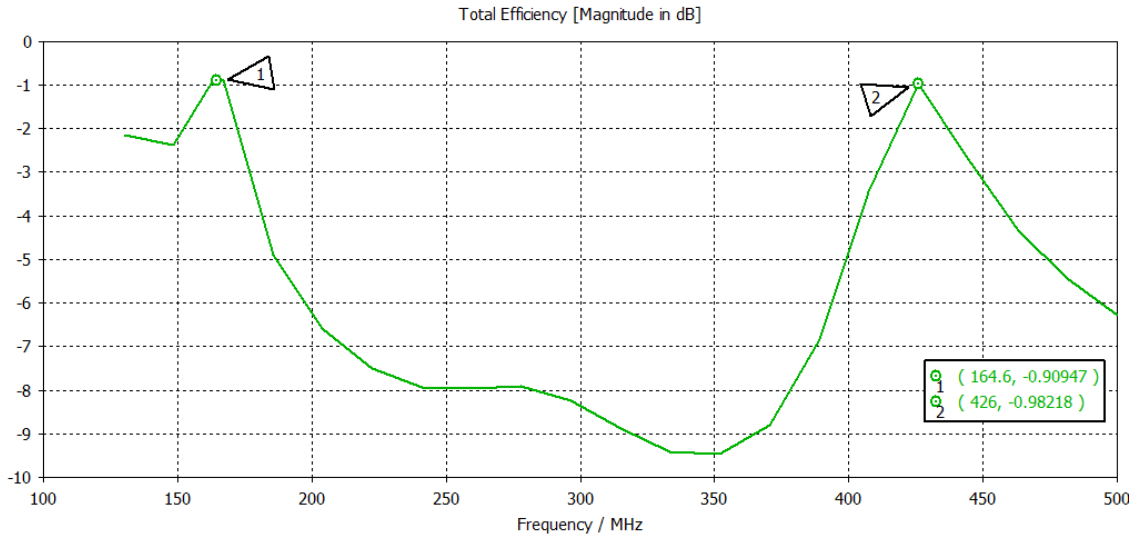

Figure 50. A2-P2. Antenna efficiency dependent on range frequency 130-500 MHz.

A.2.2.4 Electric field

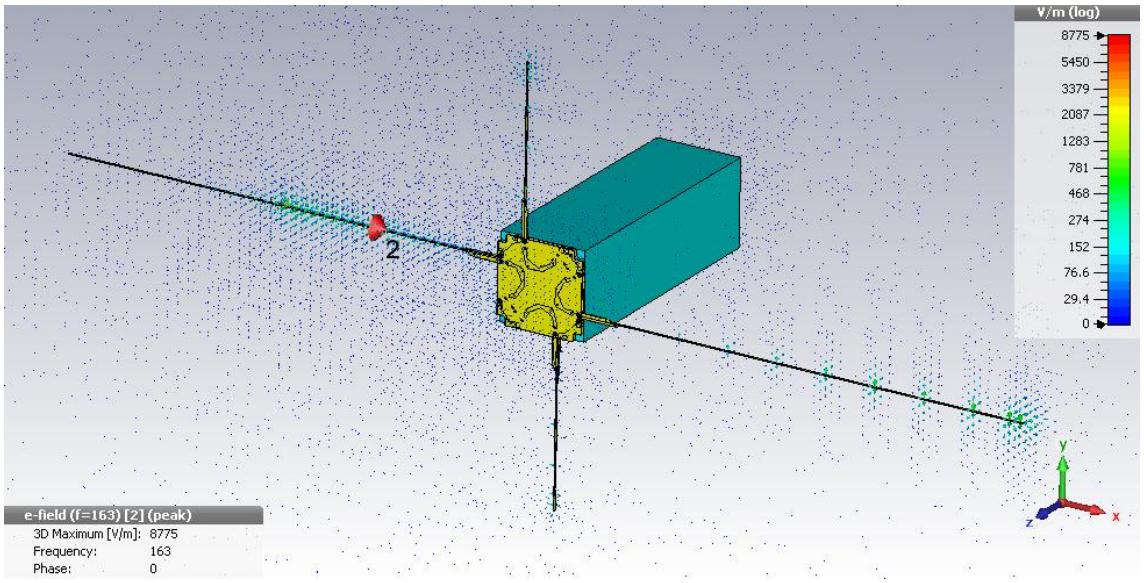

Figure 51. A2-P2. Electric field (163 MHz).

A.2.2.5 Magnetic field

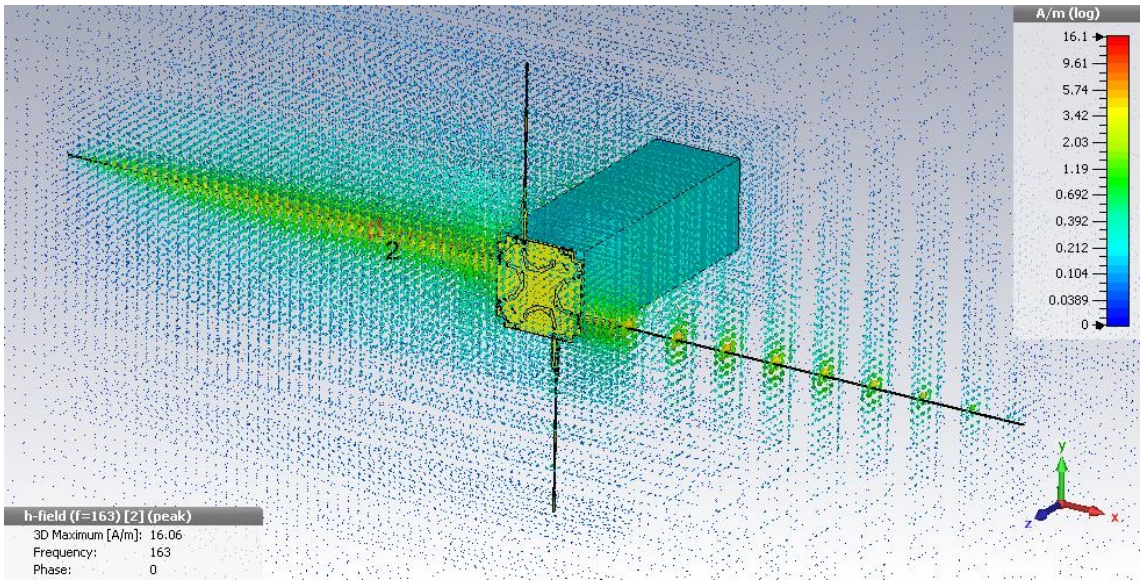

Figure 52. A2-P2. Magnetic field (163 MHz).

A.2.3 Dipole P1 & P3

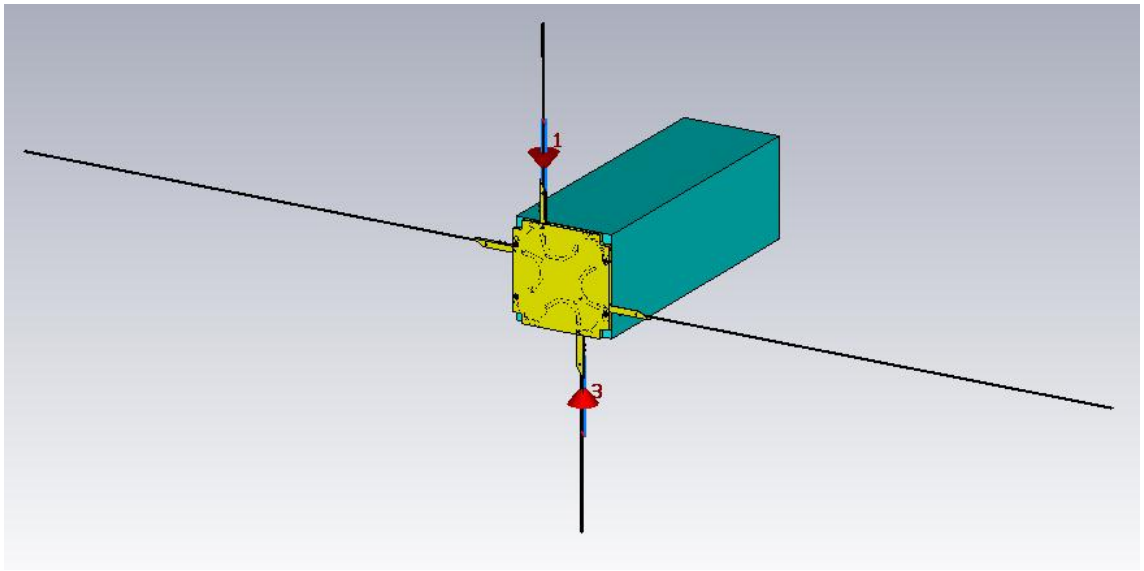

Figure 53. A2-Dipole. 3U UHF antenna CAD model.

A.2.3.1 Scattering Parameters (S – Parameters)

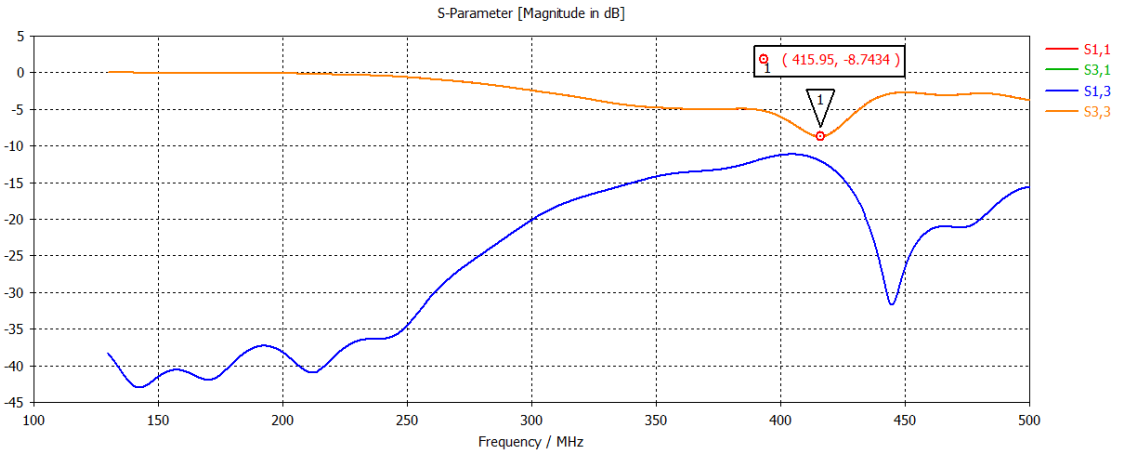

Figure 54. A2-Dipole. Return loss and insertion loss.

A.2.3.2 Radiation Pattern

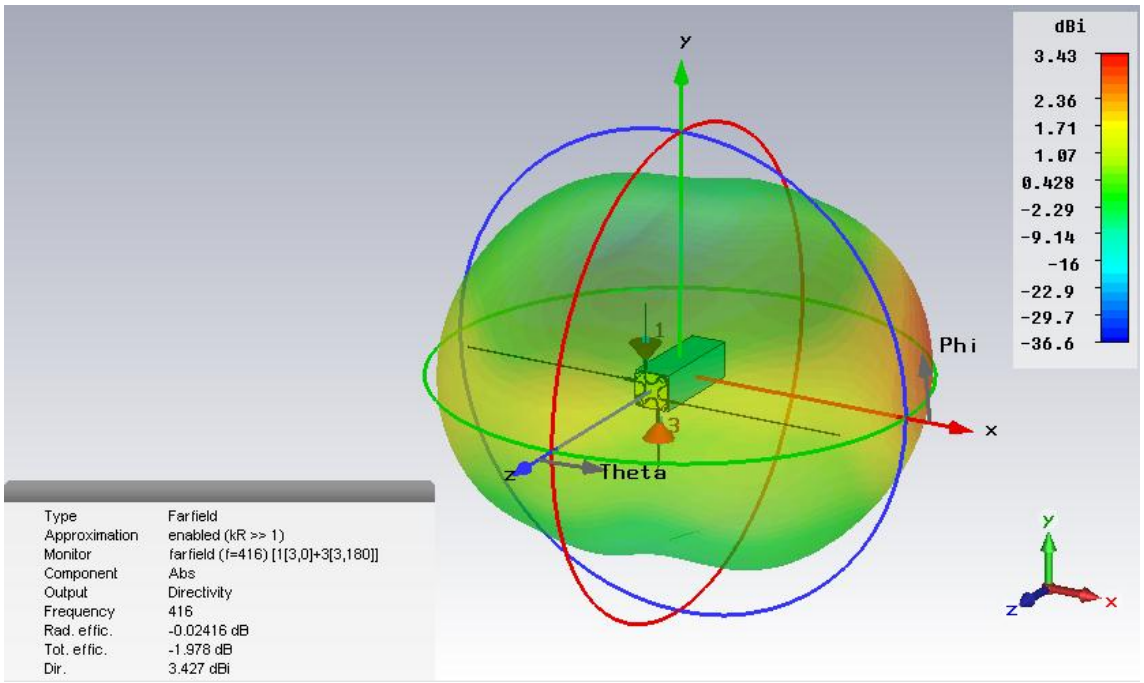

Figure 55. A2-Dipole. 3D Directivity Pattern (416 MHz).

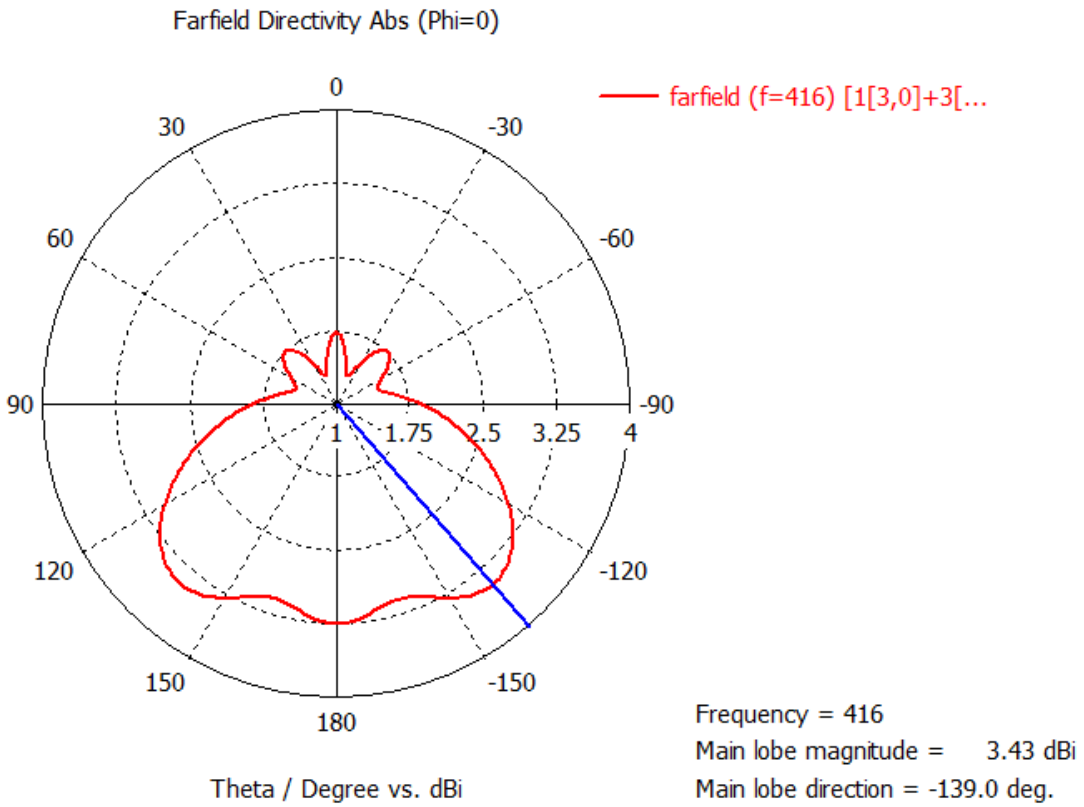

Figure 56. A2-Dipole. Directivity Polar Diagram (416 MHz).

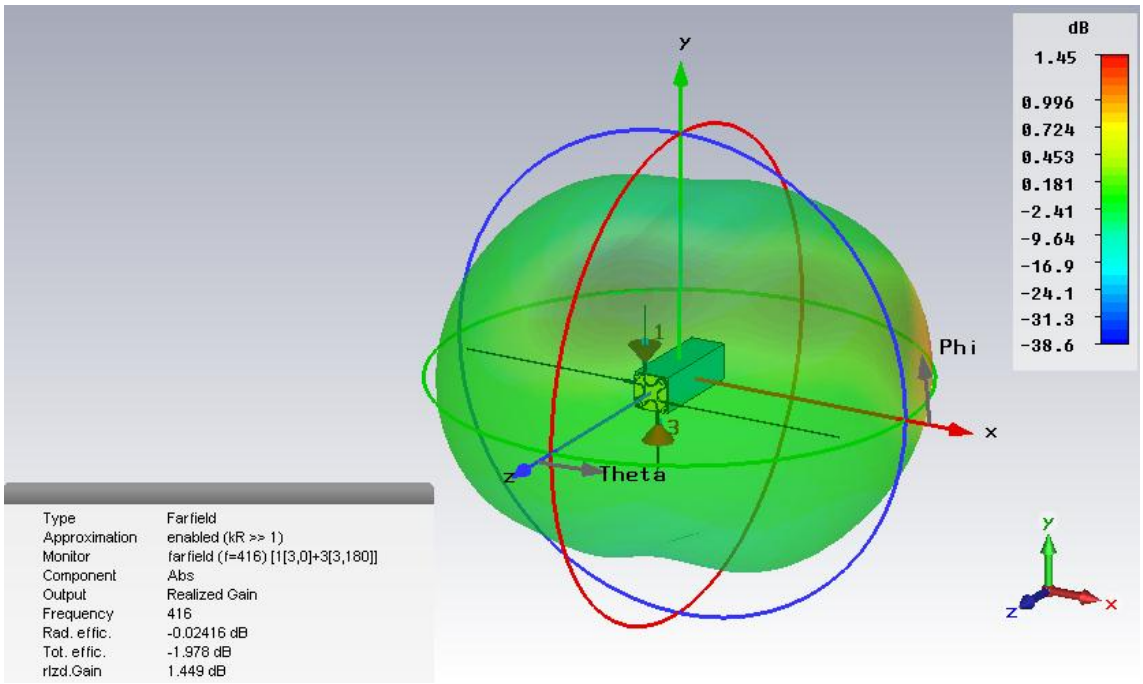

Figure 57. A2-Dipole. 3D Realized Gain Pattern (416 MHz).

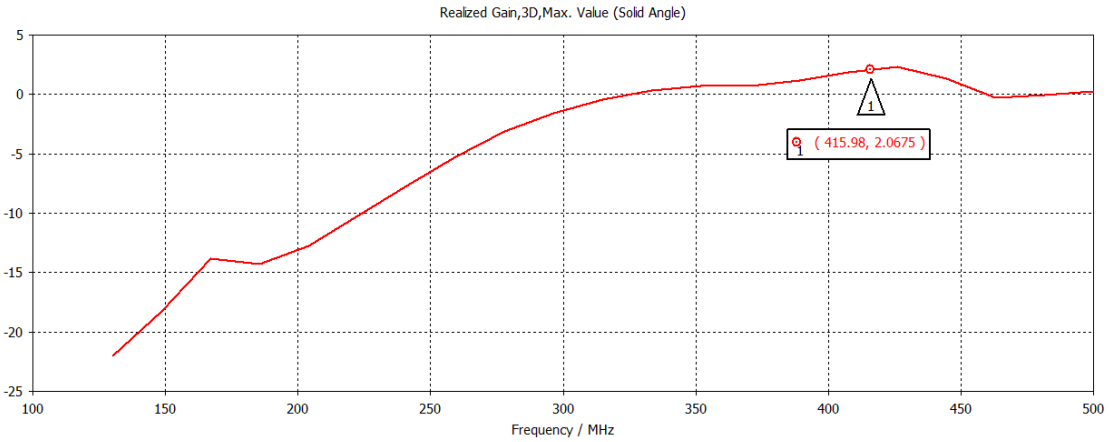

Figure 58. A2-Dipole. Realized Gain dependent on range frequency 130-500 MHz.

A.2.3.3 Efficiency

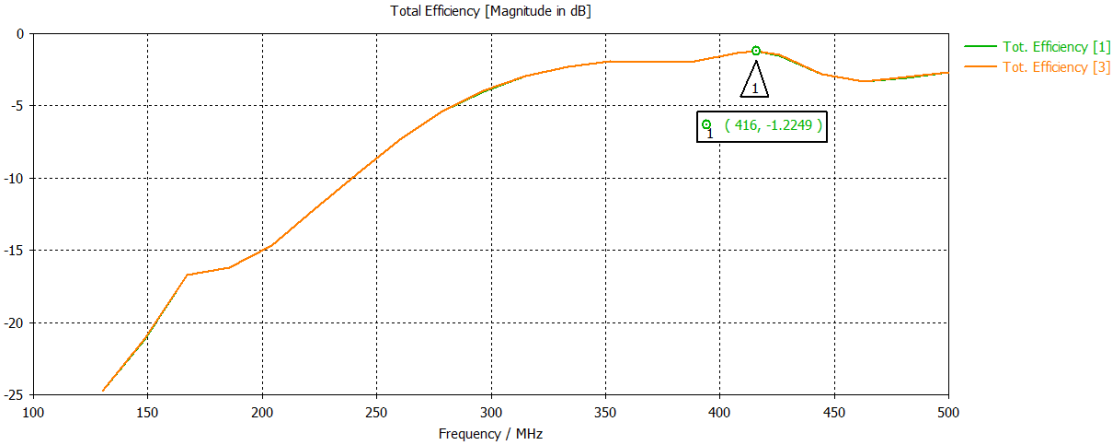

Figure 59. A2-Dipole. Antenna efficiency dependent on range frequency 130-500 MHz.

A.2.3.4 Electric field

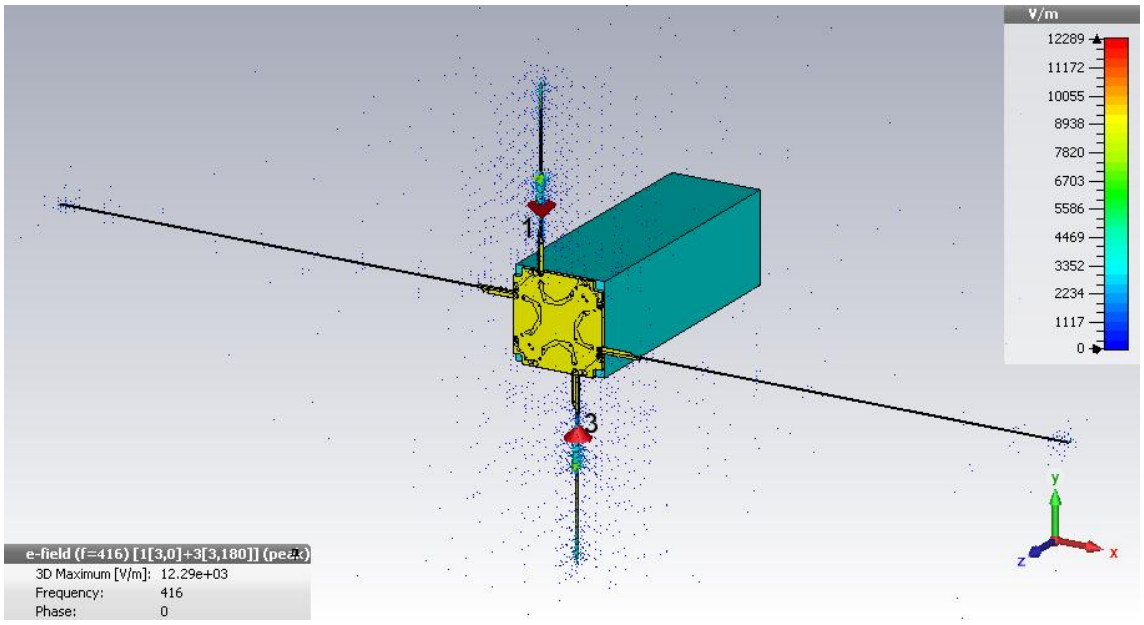

Figure 60. A2-Dipole. Electric field (416 MHz).

A.2.3.5 Magnetic field

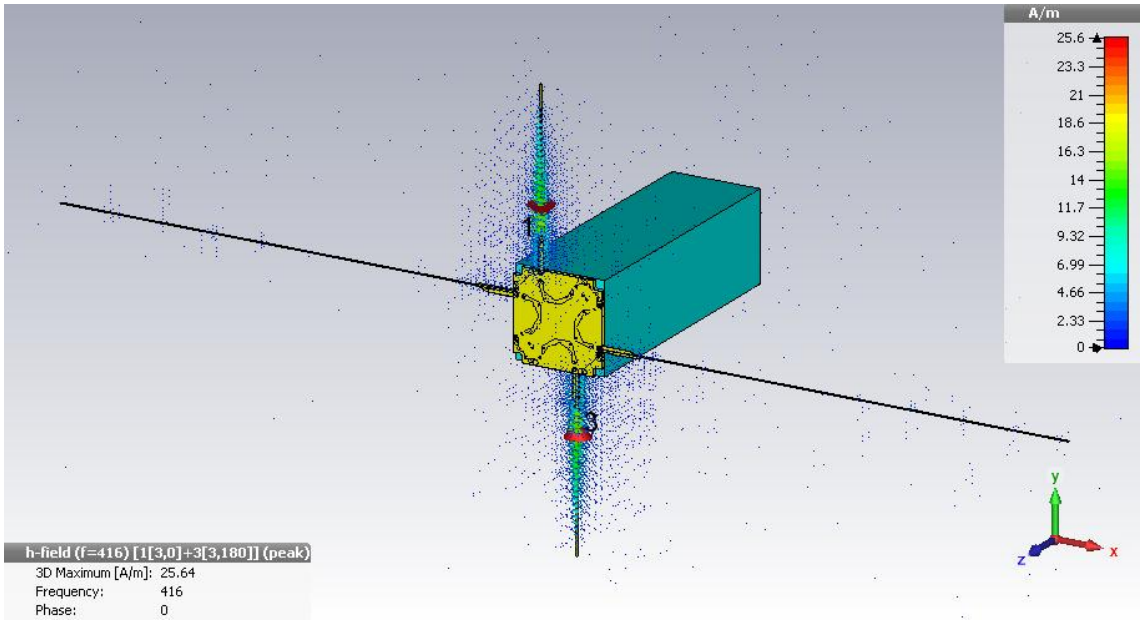

Figure 61. A2-Dipole. Magnetic field (416 MHz).

A.2.4 Turnstile: All Ports

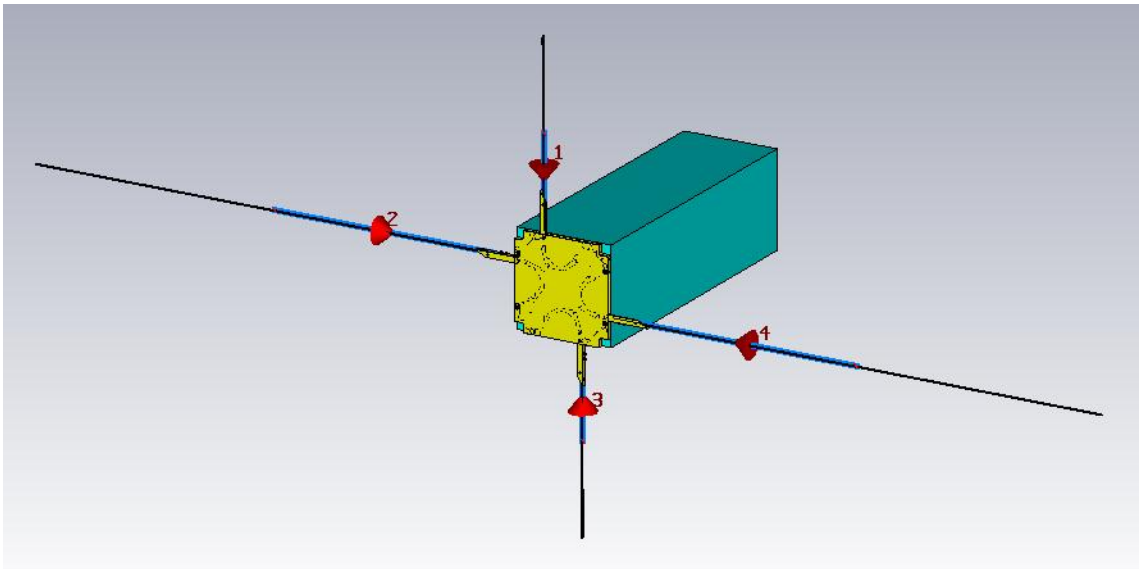

Figure 62. A2-Turnstile. 3U UHF antenna CAD model.

A.2.4.1 Scattering Parameters (S – Parameters)

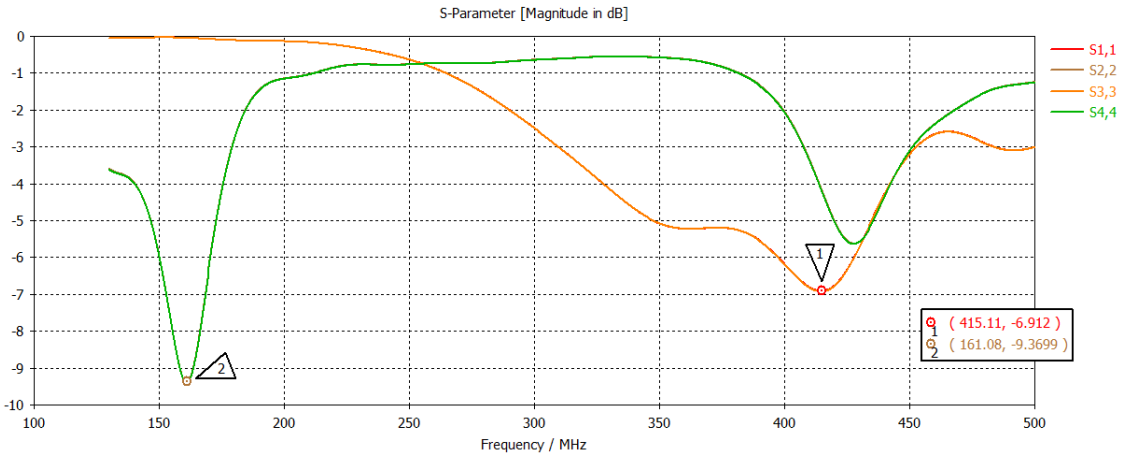

Figure 63. A2-Turnstile. Return loss.

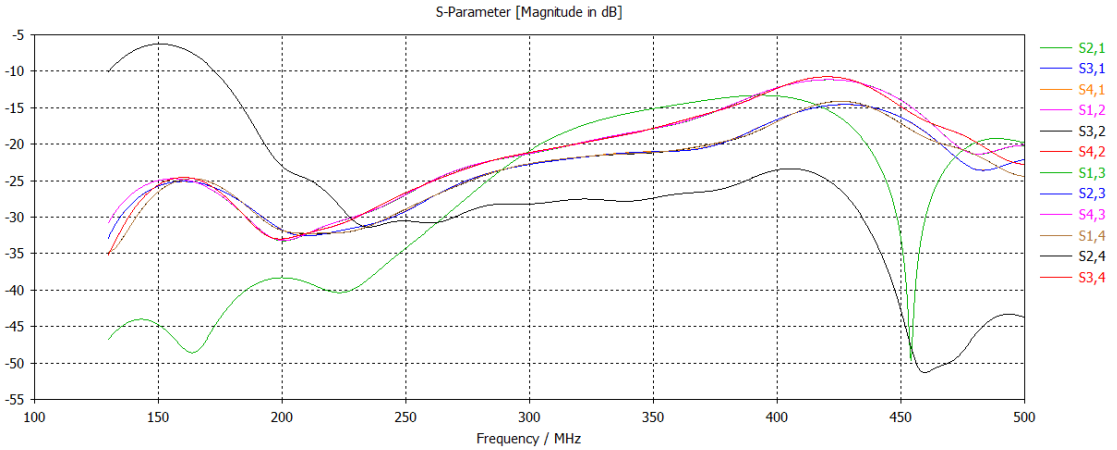

Figure 64. A2-Turnstile. Insertion loss.

A.2.4.2 Radiation Pattern

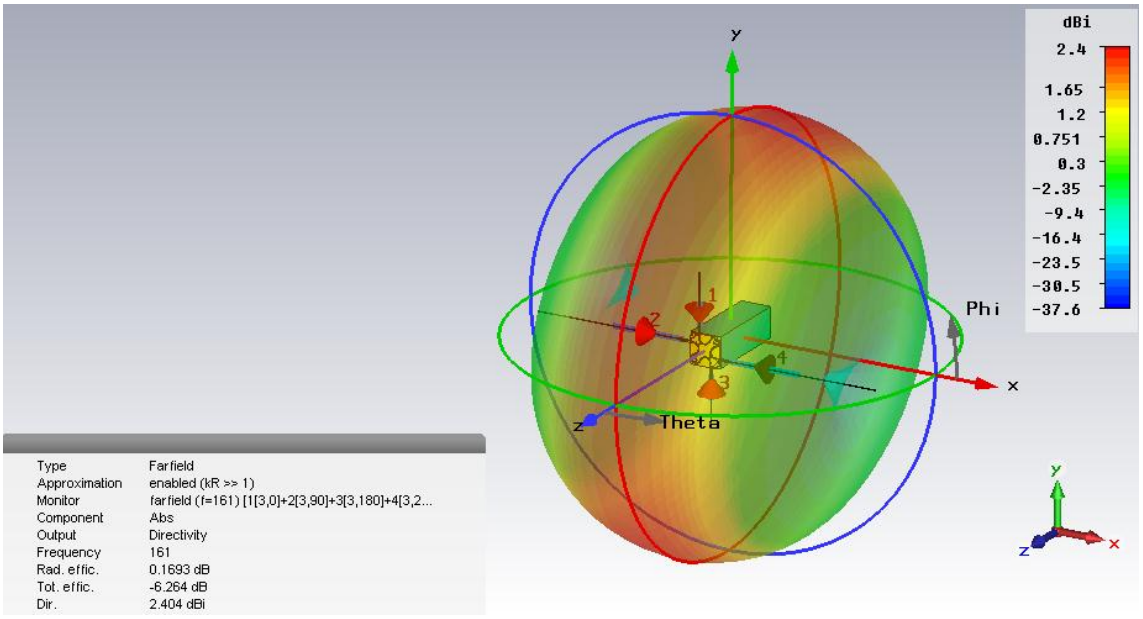

Figure 65. A2-Turnstile. 3D Directivity Pattern (161 MHz).

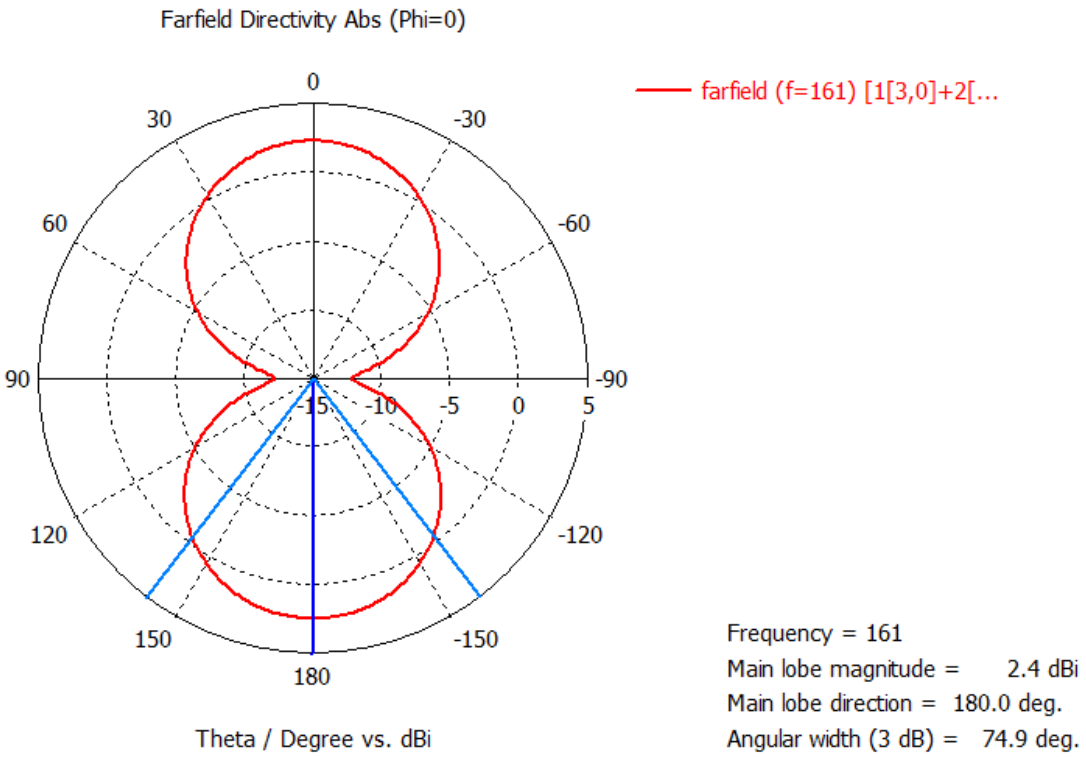

Figure 66. A2-Turnstile. Directivity Polar Diagram (161 MHz).

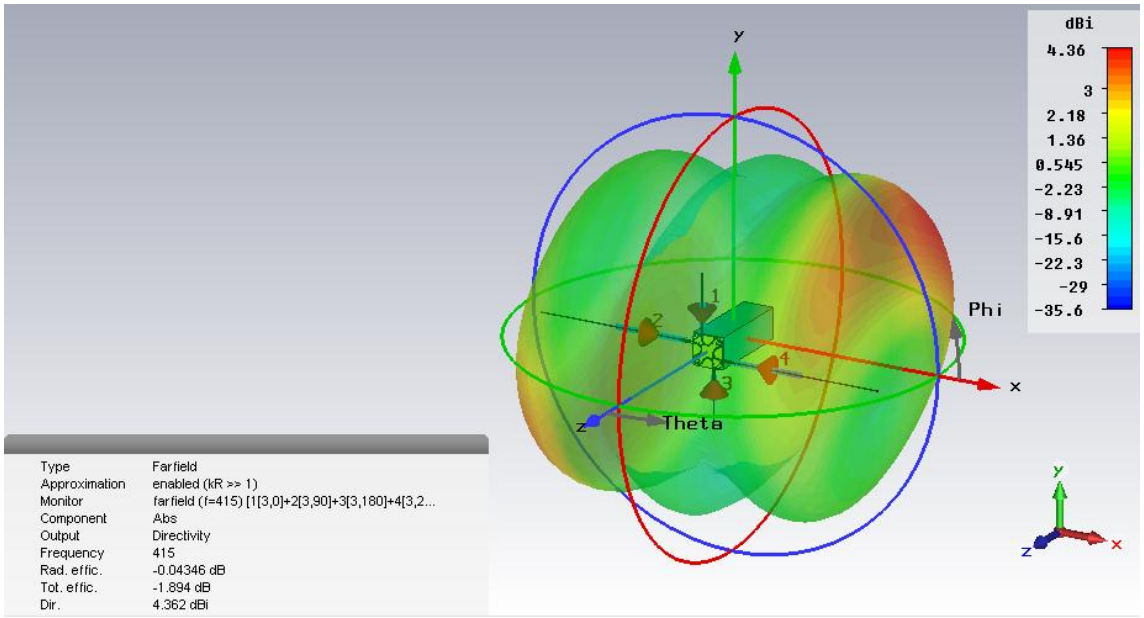

Figure 67. A2-Turnstile. 3D Directivity Pattern (415 MHz).

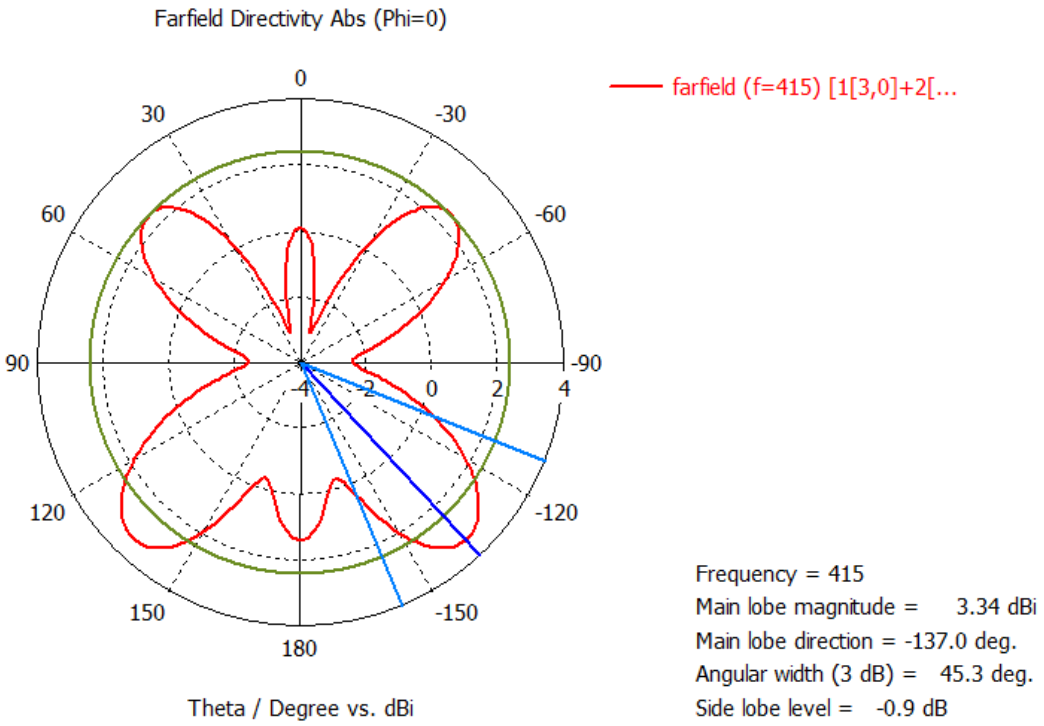

Figure 68. A2-Turnstile. Directivity Polar Diagram (415 MHz).

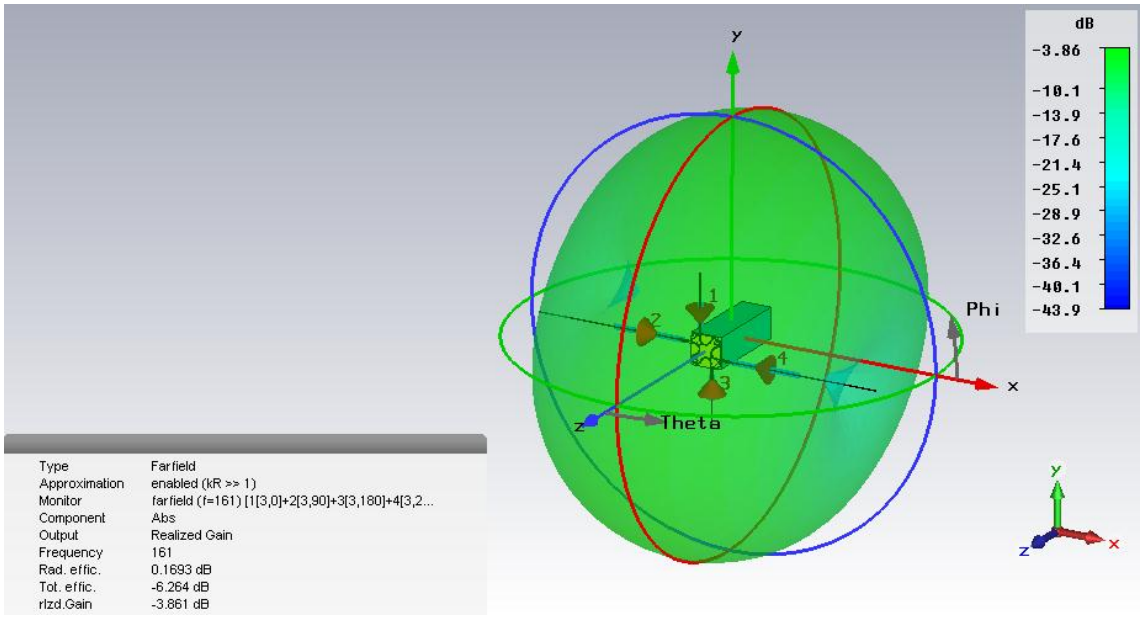

Figure 69. A2-Turnstile. 3D Realized Gain Pattern (161 MHz).

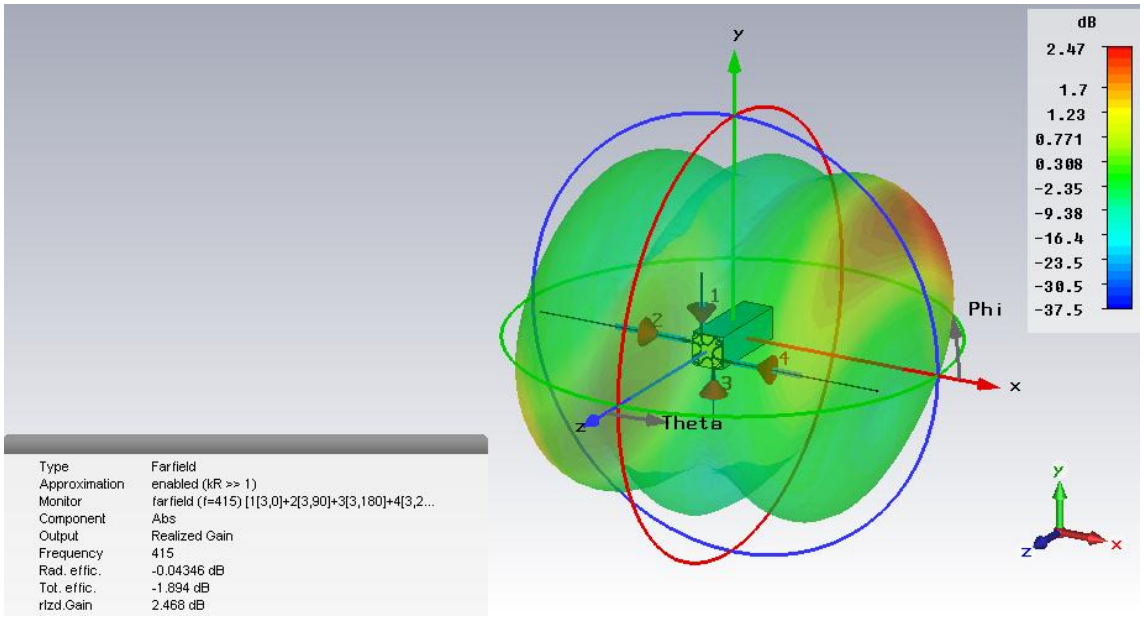

Figure 70. A2-Turnstile. 3D Realized Gain Pattern (415 MHz).

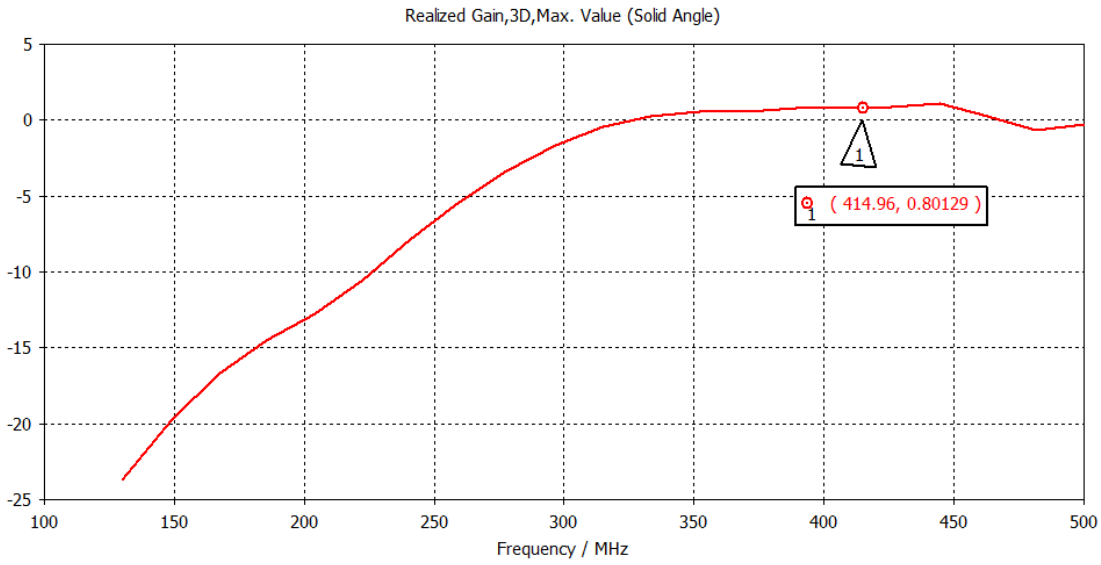

Figure 71. A2-Turnstile. Realized Gain dependent on range frequency 130-500 MHz. P1 and P3.

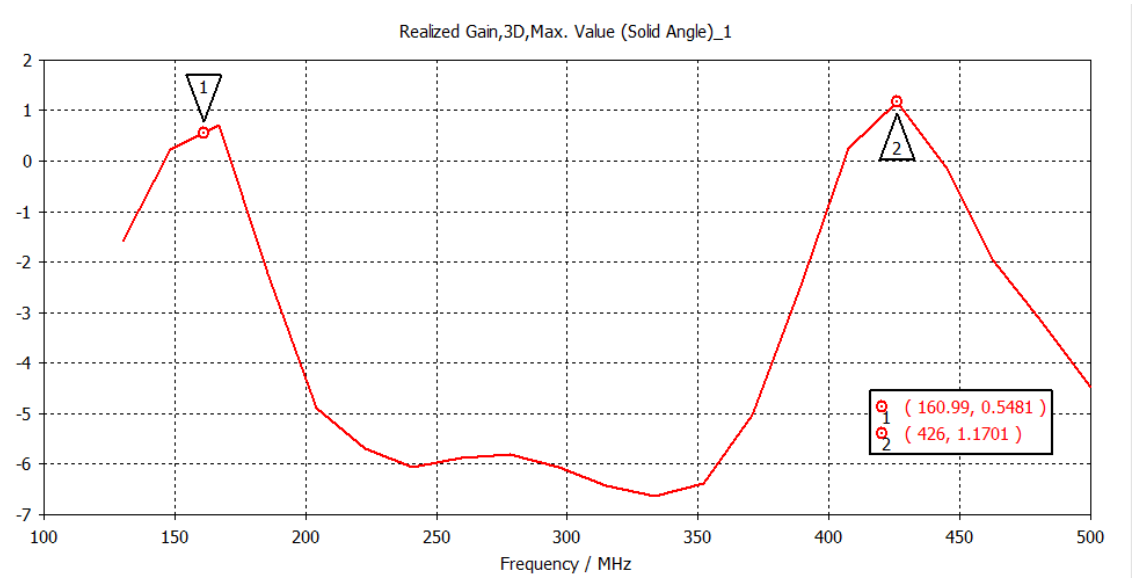

Figure 72. A2-Turnstile. Realized Gain dependent on range frequency 130-500 MHz. P2 and P4.

A.2.4.3 Efficiency

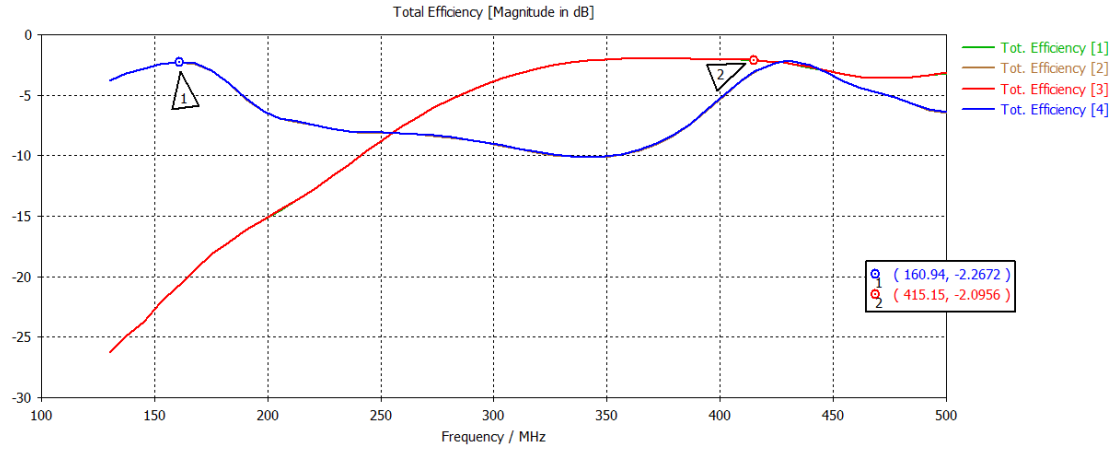

Figure 73. A2-Turnstile. Antenna efficiency dependent on range frequency 130-500 MHz.

A.2.4.4 Electric field

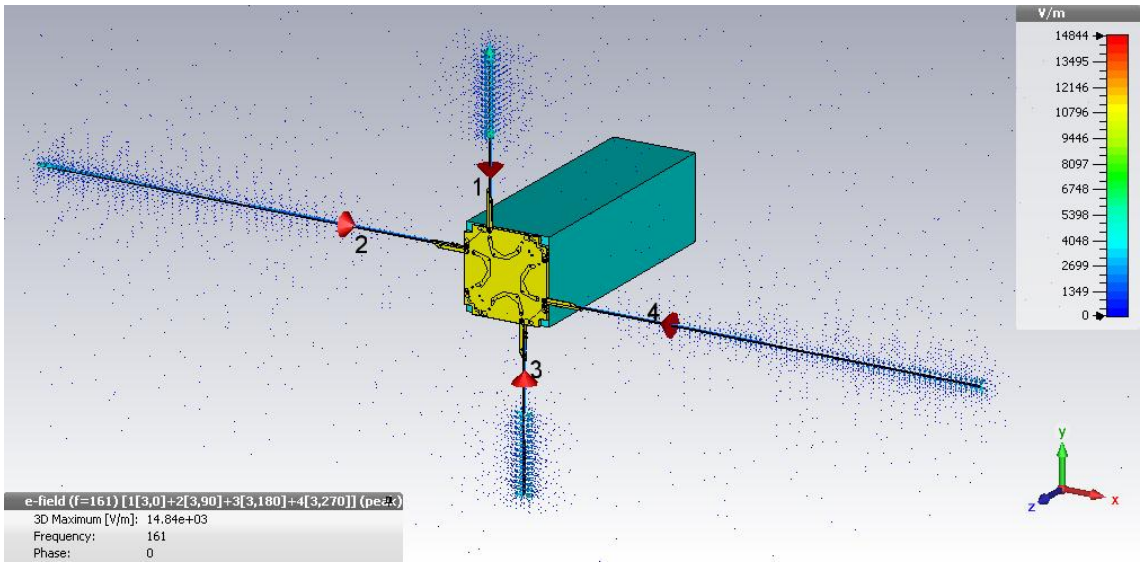

Figure 74. A2-Turnstile. Electric field (161 MHz).

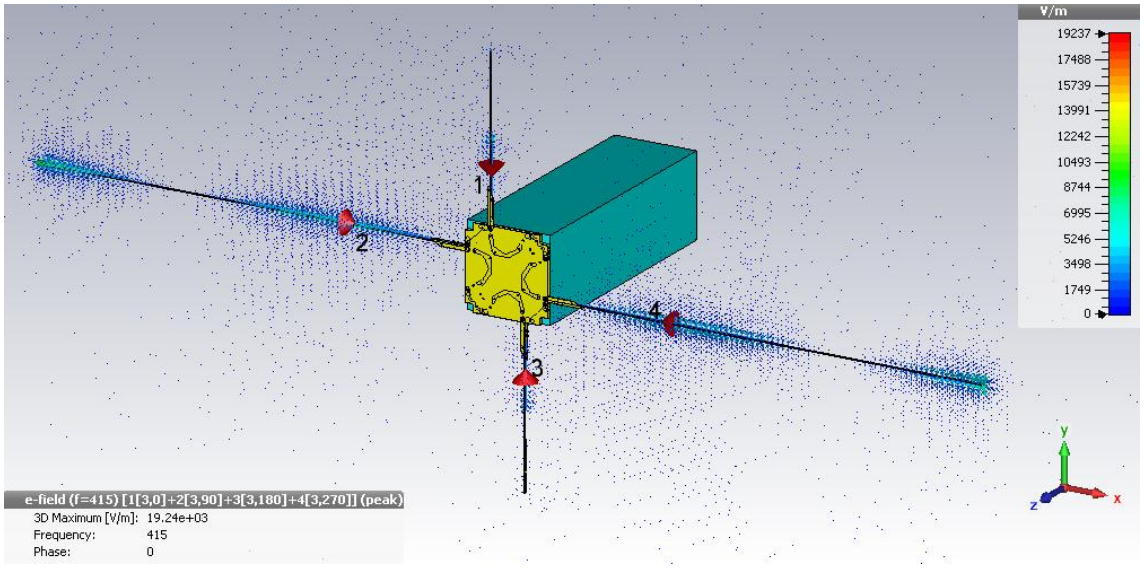

Figure 75. A2-Turnstile. Electric field (415 MHz).

A.2.4.5 Magnetic field

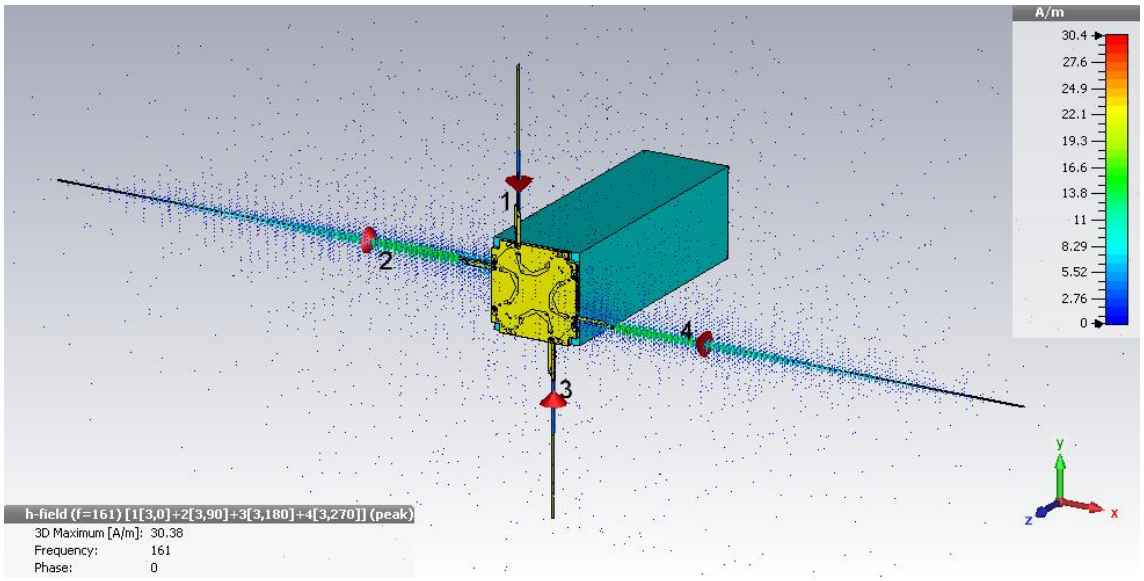

Figure 76. A2-Turnstile. Magnetic field (161 MHz).

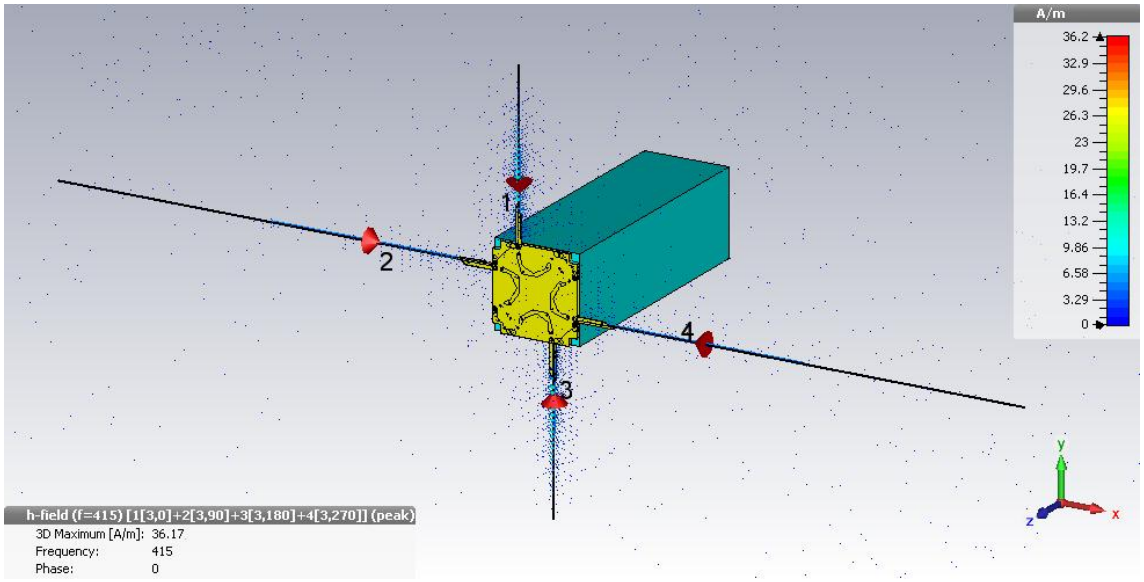

Figure 77. A2-Turnstile. Magnetic field (415 MHz).

A.3 ISARA UHF antenna

A.3.1 Monopole P1

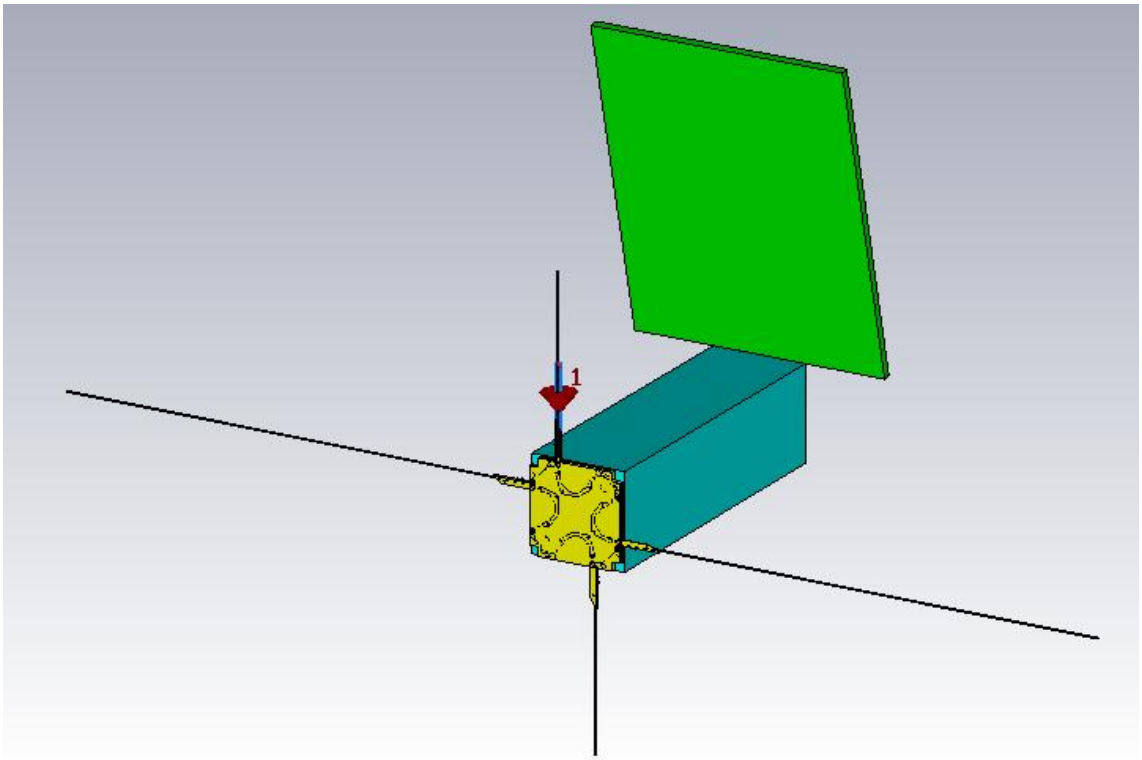

Figure 78. A3-P1. ISARA UHF antenna CAD model.

A.3.1.1 Scattering Parameters (S – Parameters)

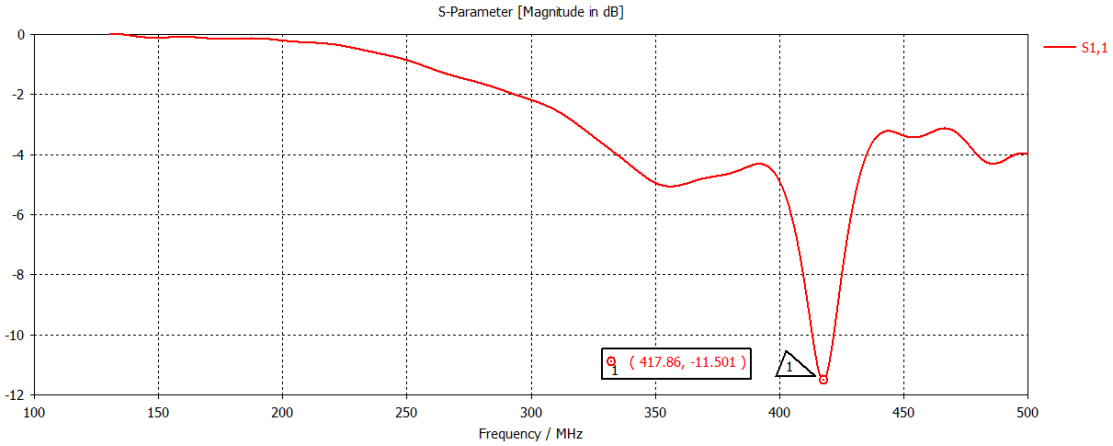

Figure 79. A3-P1.Return loss.

A.3.1.2 Radiation Pattern

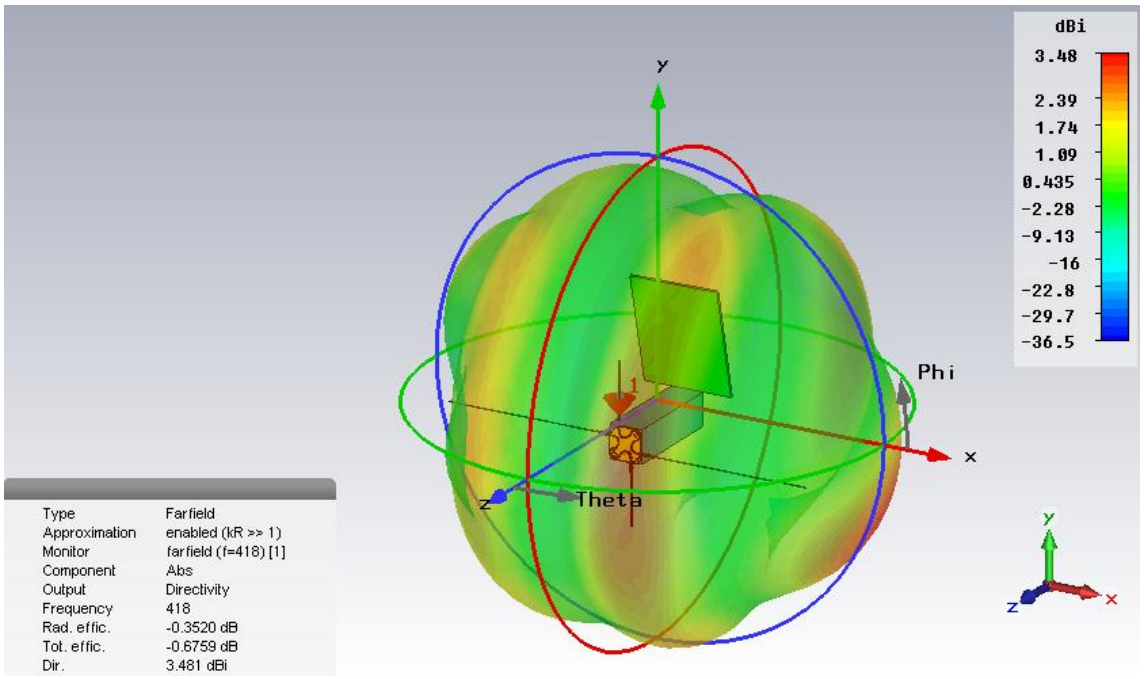

Figure 80. A3-P1. 3D Directivity Pattern (418 MHz).

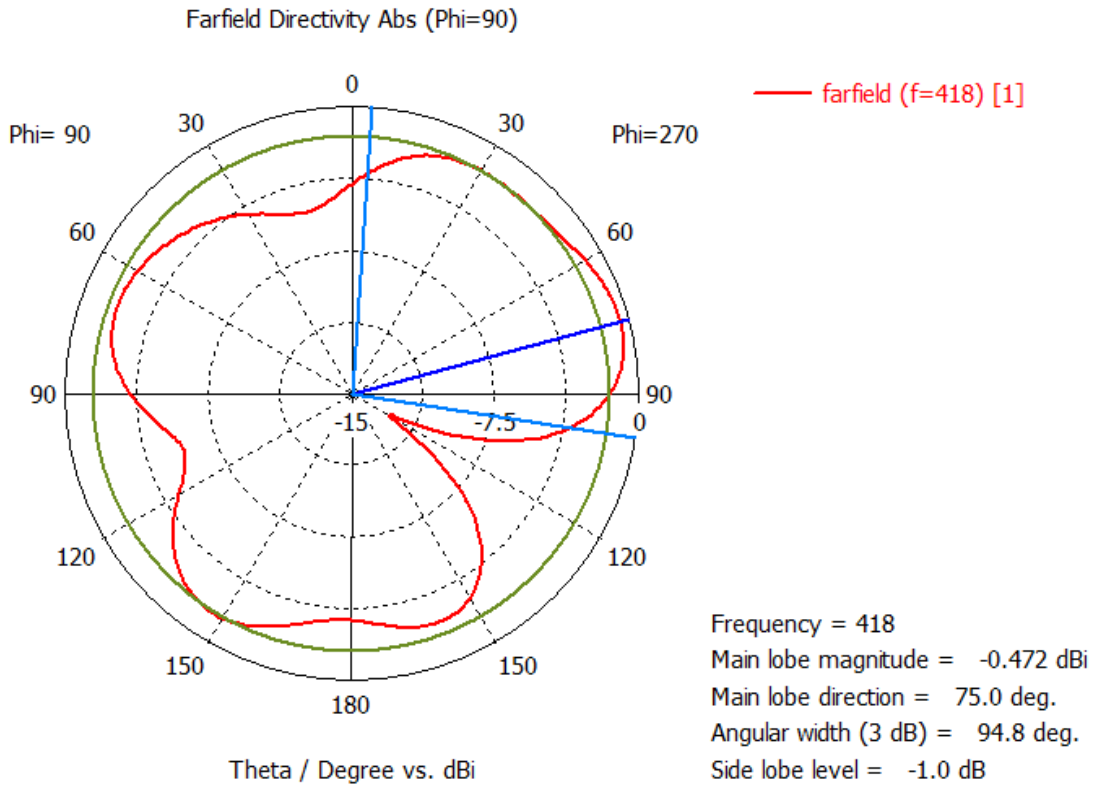

Figure 81. A3-P1. Directivity Polar Diagram (418 MHz).

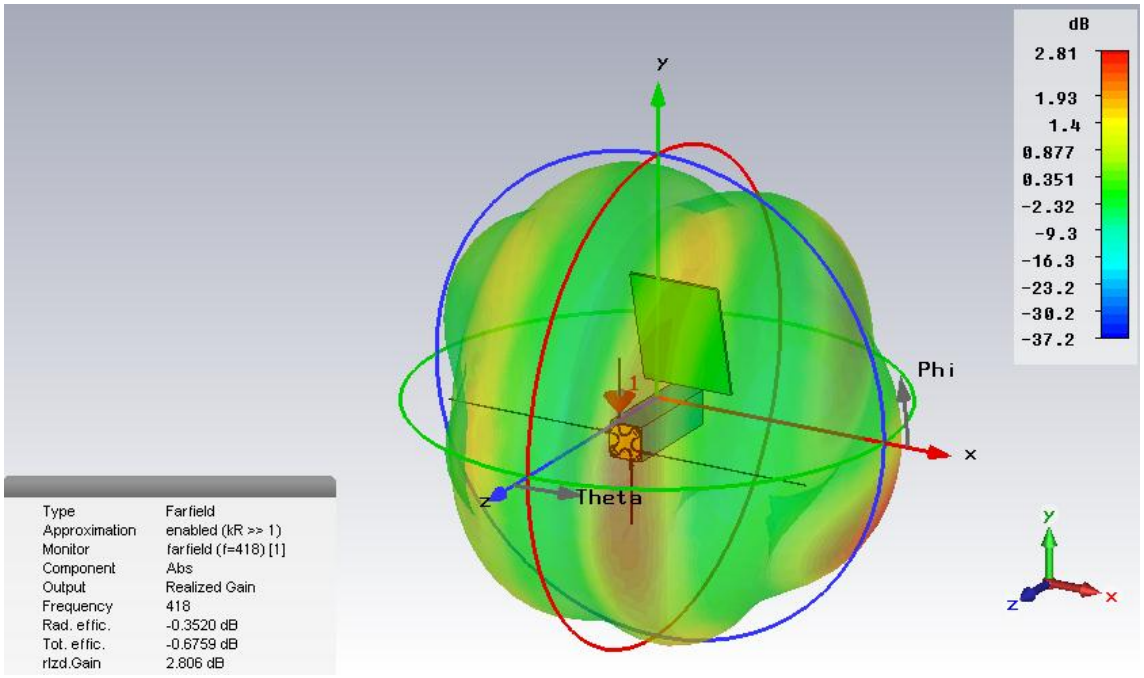

Figure 82. A3-P1. 3D Realized Gain Pattern (418 MHz).

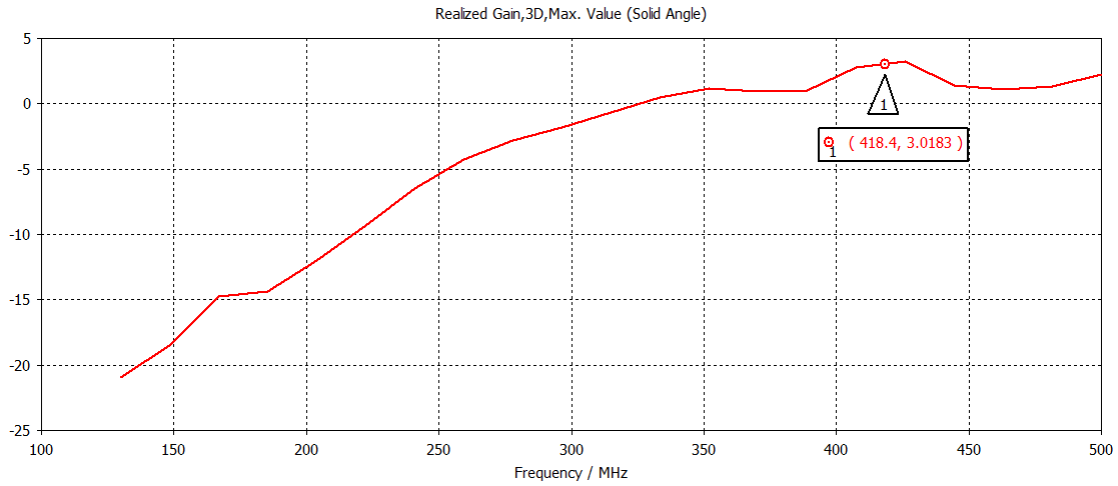

Figure 83. A3-P1.Realized Gain dependent on range frequency 130-500 MHz.

A.3.1.3 Efficiency

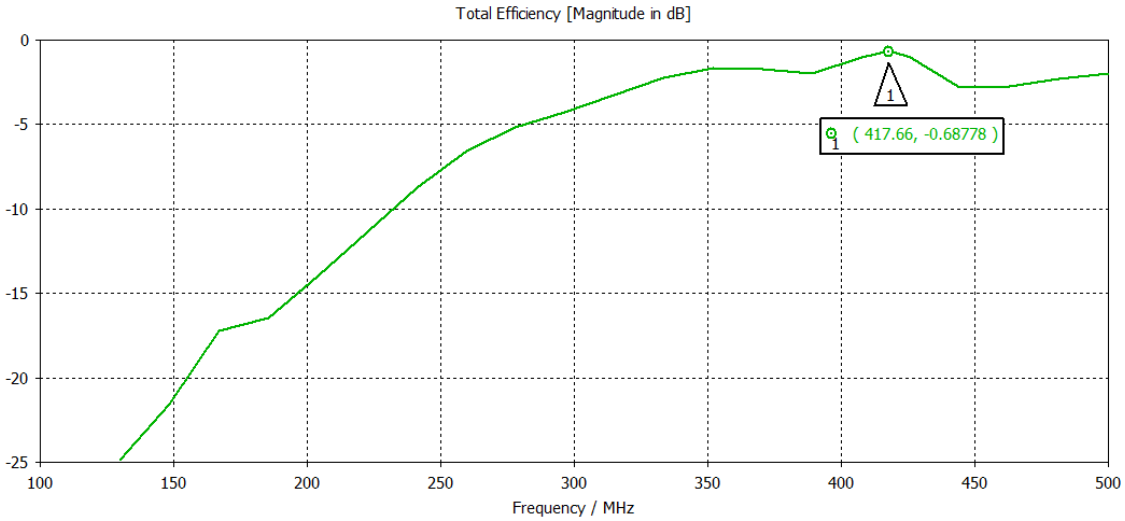

Figure 84. A3-P1. Antenna efficiency dependent on range frequency 130-500 MHz.

A.3.1.4 Electric field

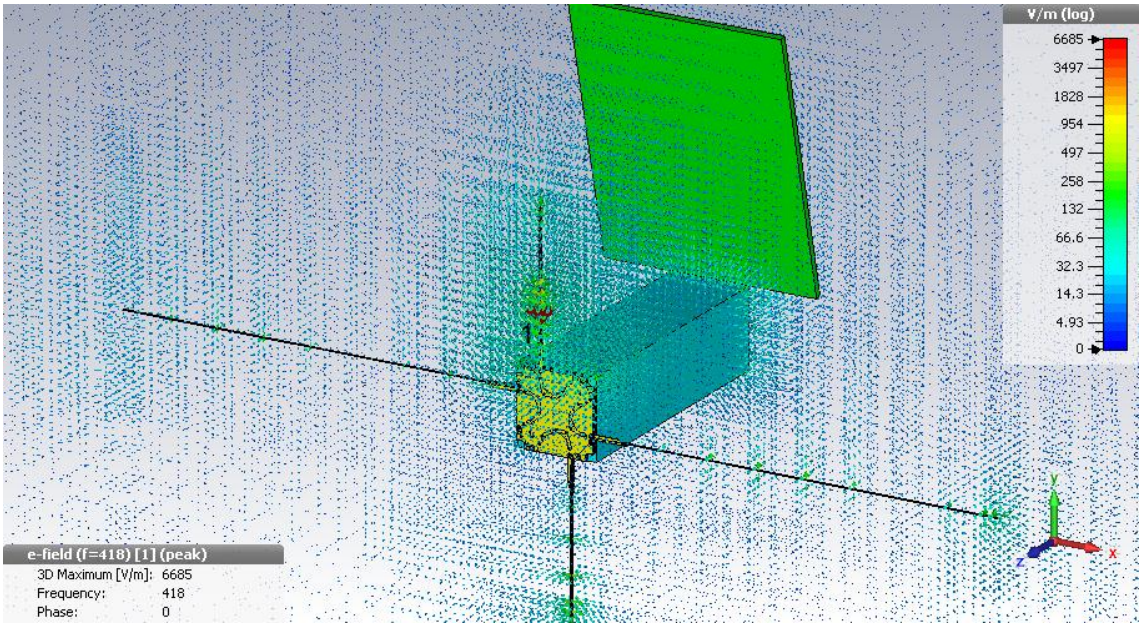

Figure 85. A3-P1. Electric field (418 MHz).

A.3.1.5 Magnetic field

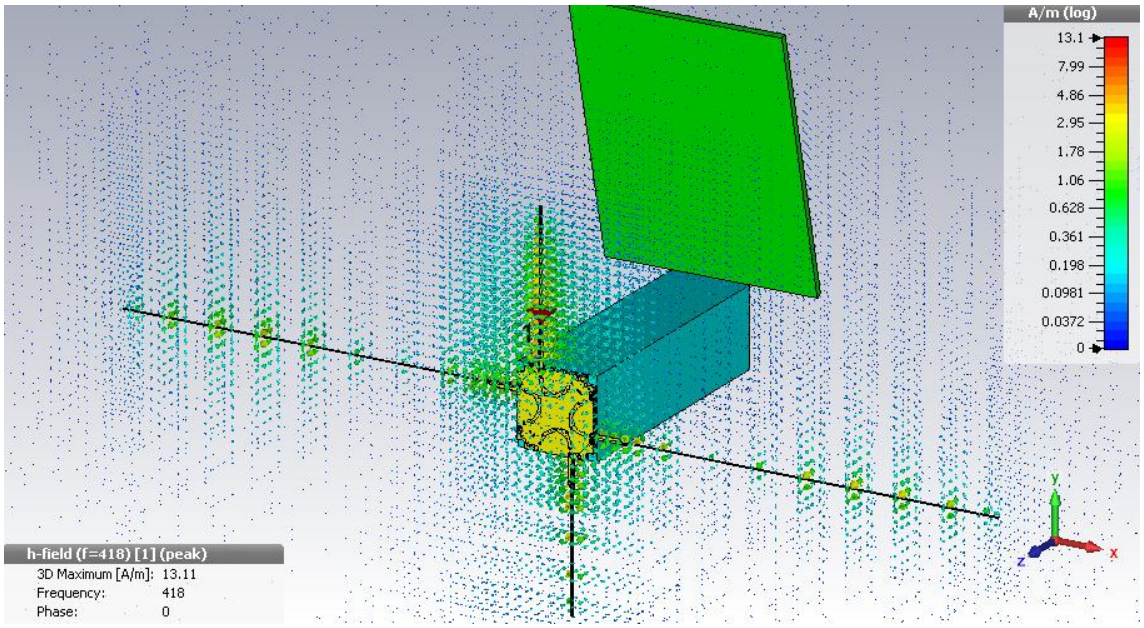

Figure 86. A3-P1. Magnetic field (418 MHz).

A.3.2 Monopole P2

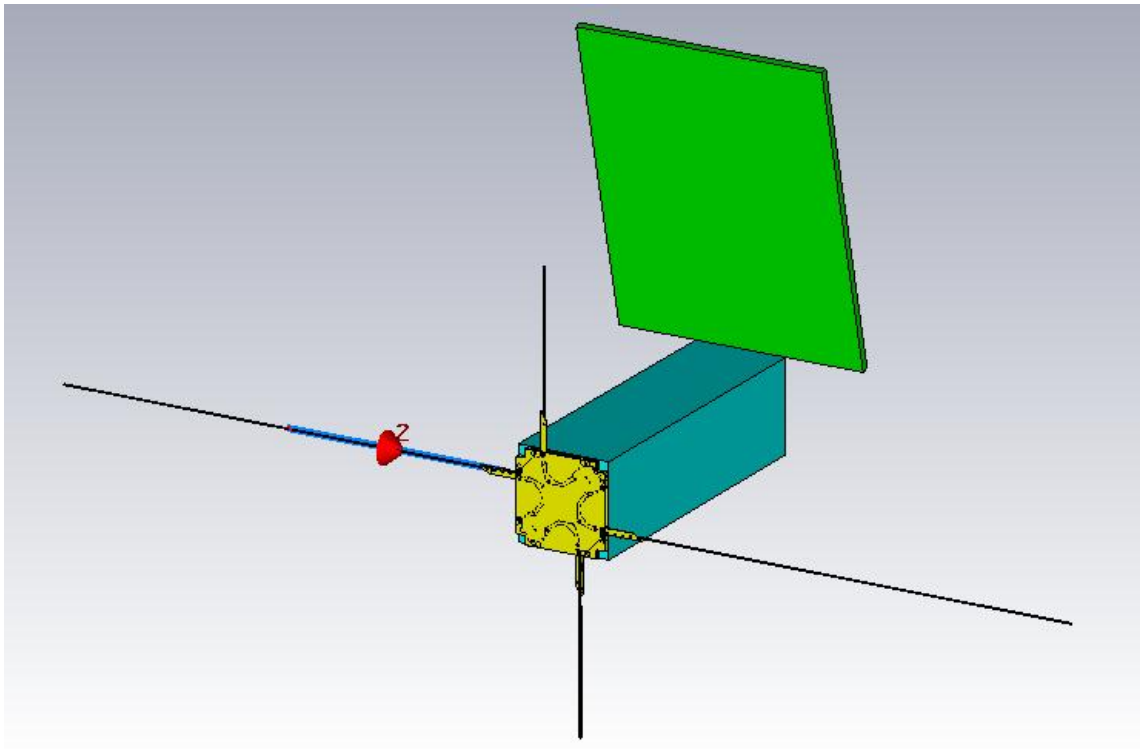

Figure 87. A3-P2. ISARA UHF antenna CAD model.

A.3.2.1 Scattering Parameters (S – Parameters)

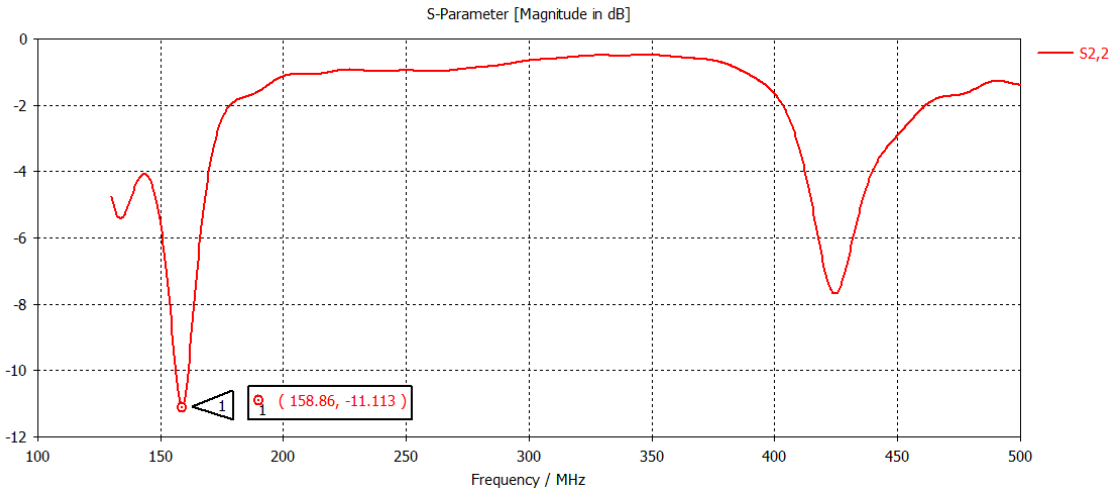

Figure 88. A3-P2. Return loss.

A.3.2.2 Radiation Pattern

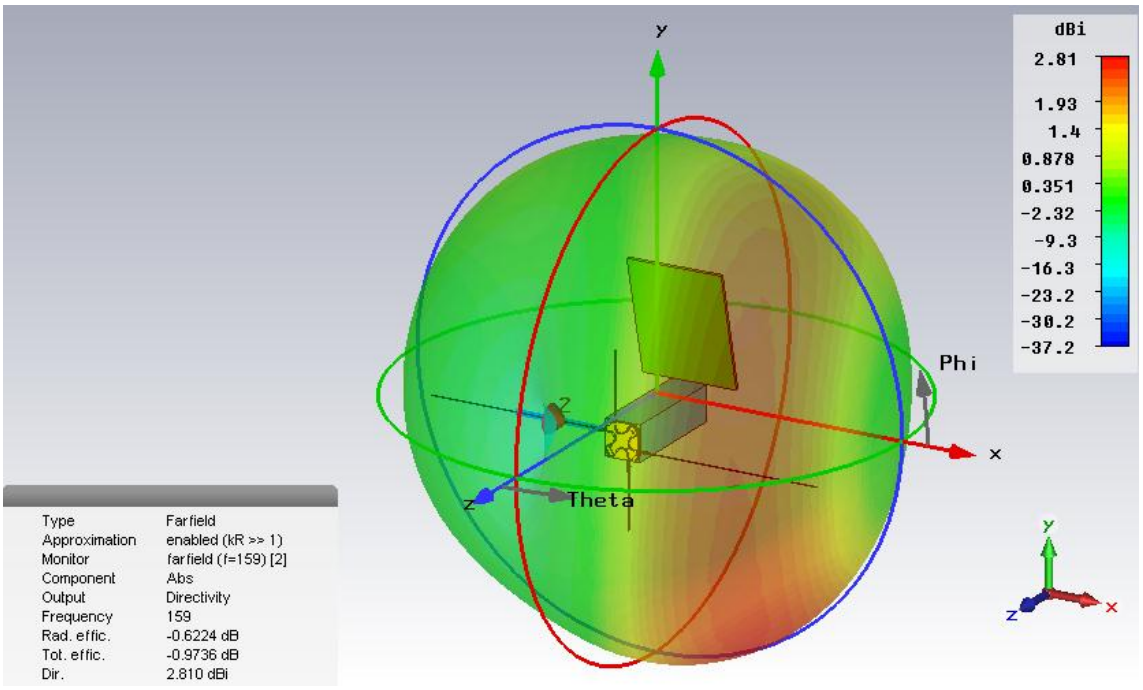

Figure 89. A3-P2. 3D Directivity Pattern (159 MHz).

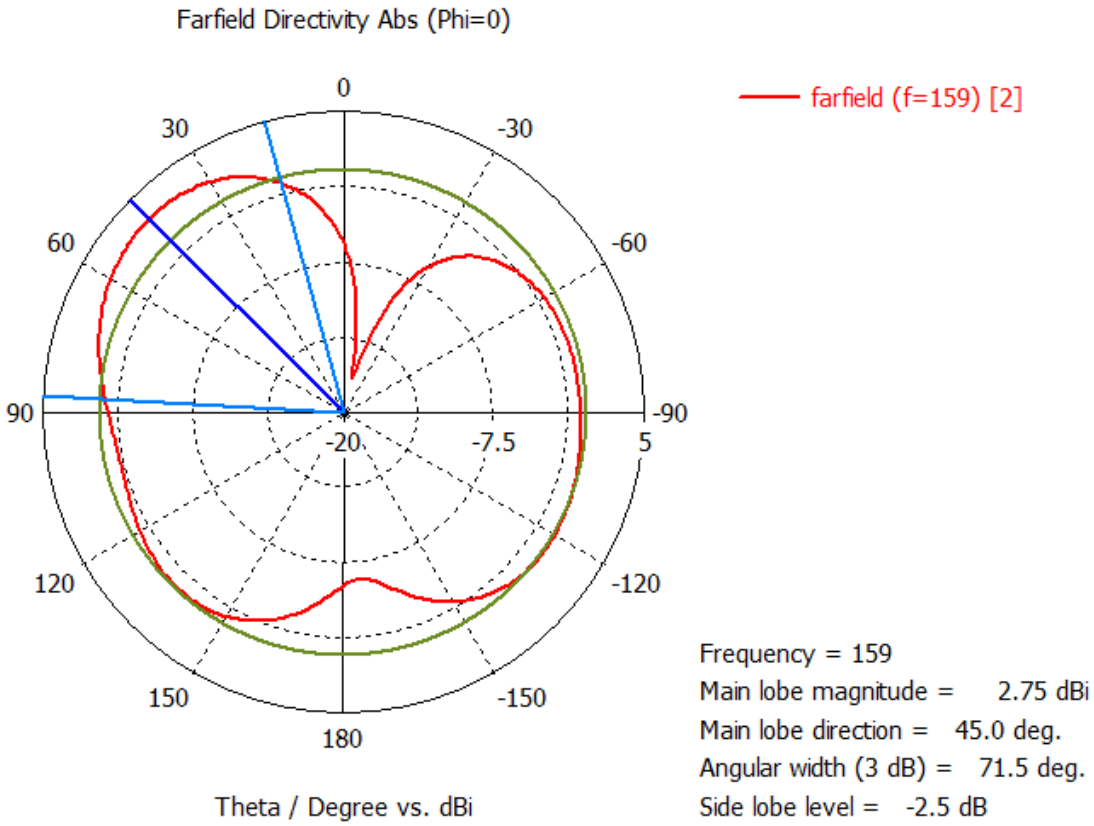

Figure 90. A3-P2. Directivity Polar Diagram (159 MHz).

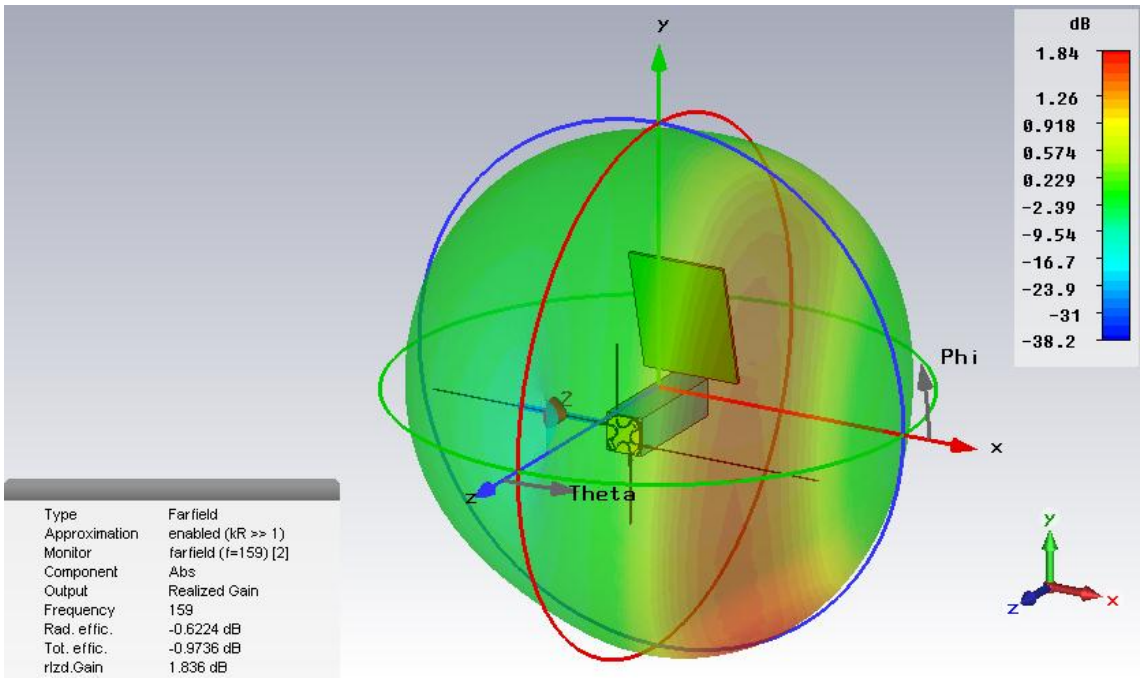

Figure 91. A3-P2. 3D Realized Gain Pattern (159 MHz).

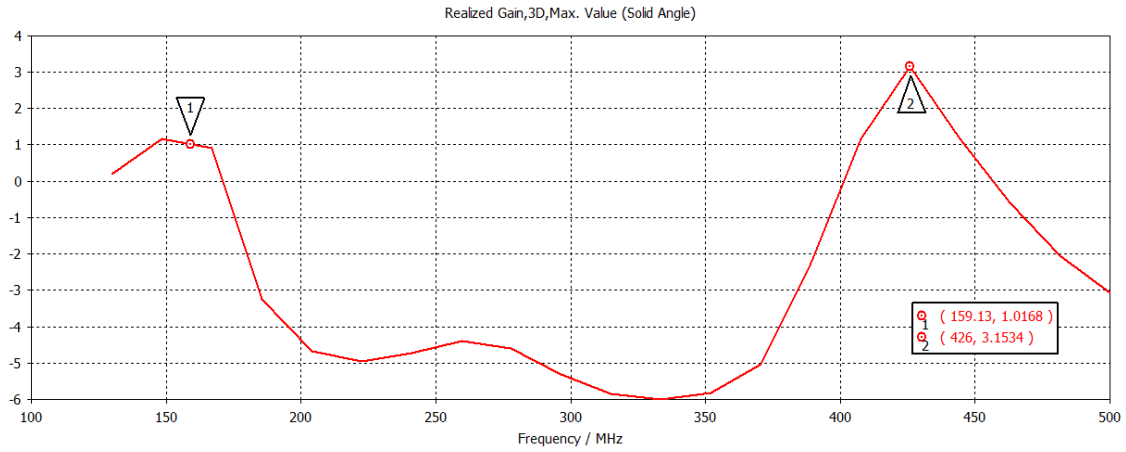

Figure 92. A3-P2. Realized Gain dependent on range frequency 130-500 MHz.

A.3.2.3 Efficiency

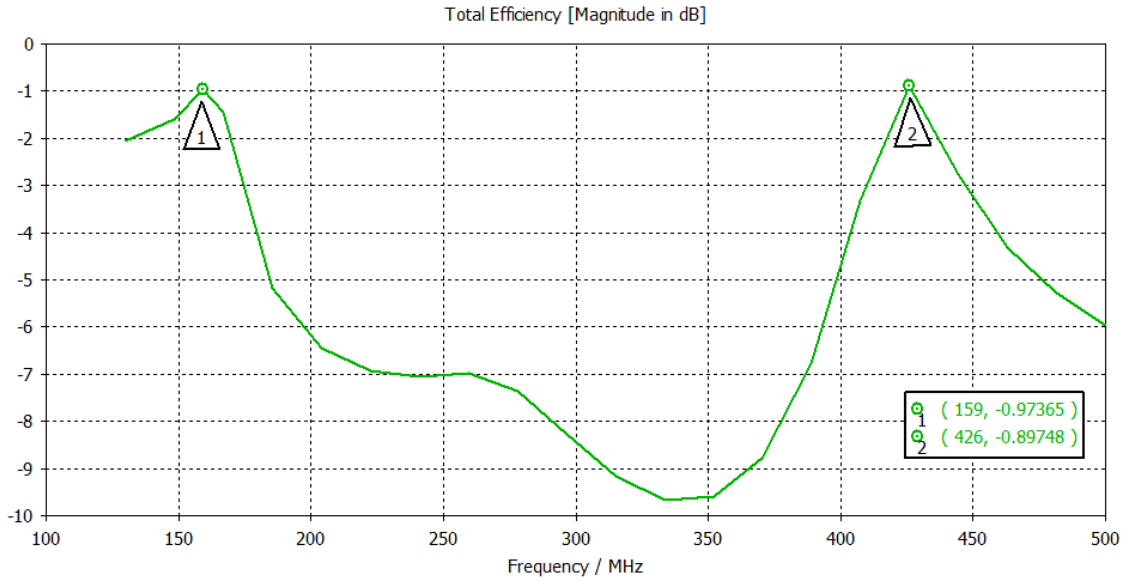

Figure 93. A3-P2. Antenna efficiency dependent on range frequency 130-500 MHz.

A.3.2.4 Electric field

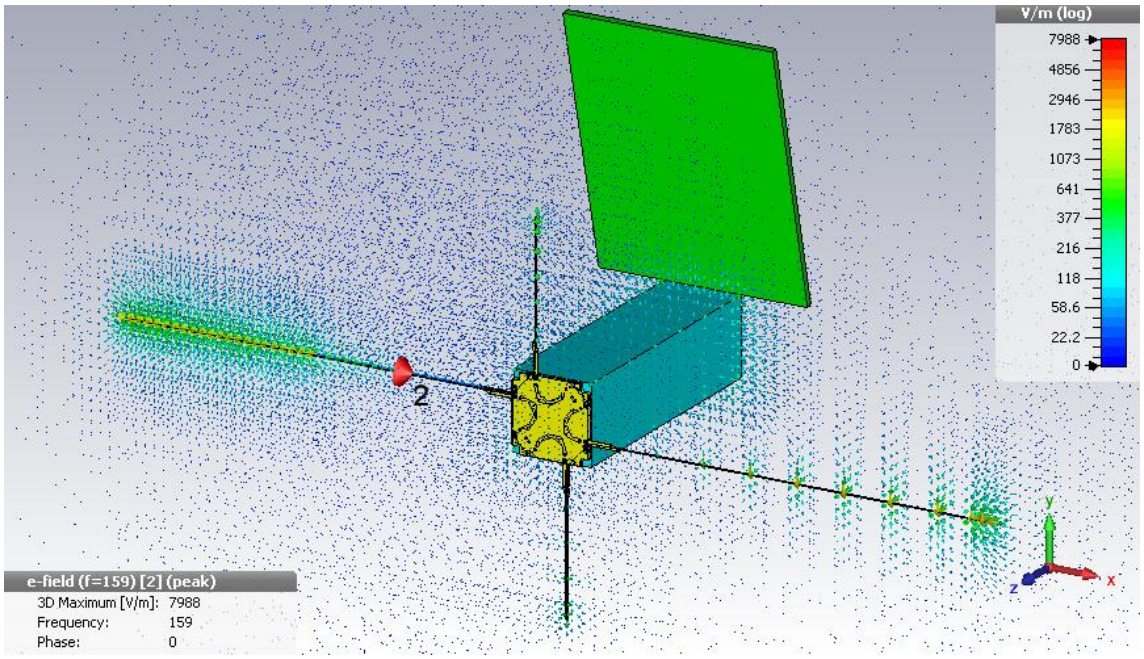

Figure 94. A3-P2. Electric field (159 MHz).

A.3.2.5 Magnetic field

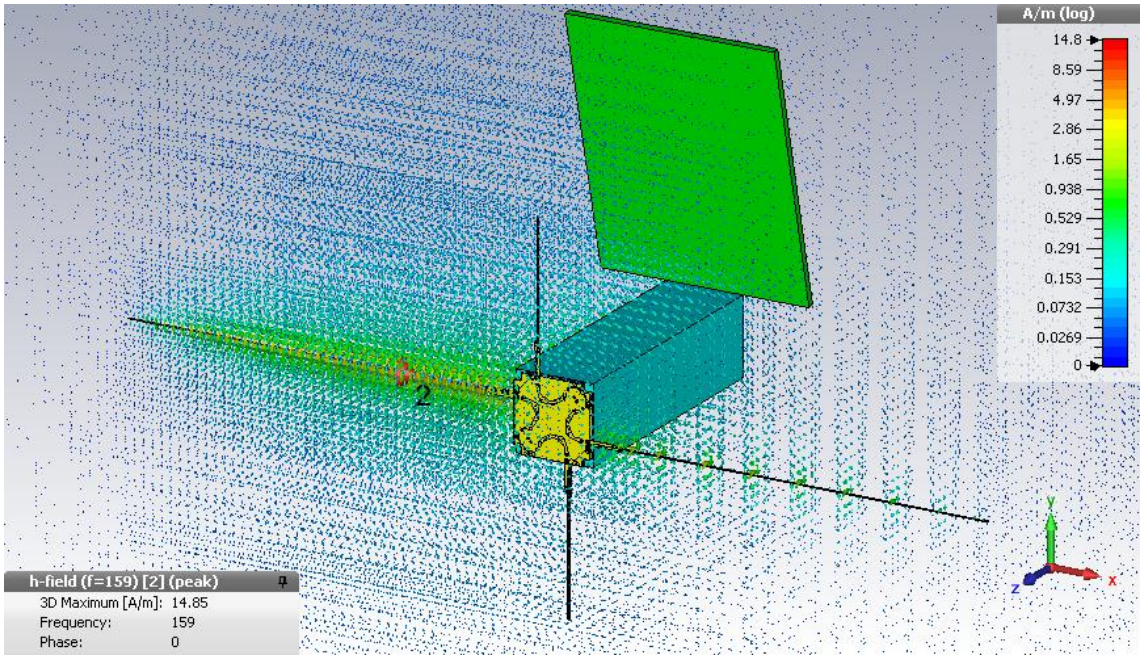

Figure 95. A3-P2. Magnetic field (159 MHz).

A.3.3 Turnstile: All Ports

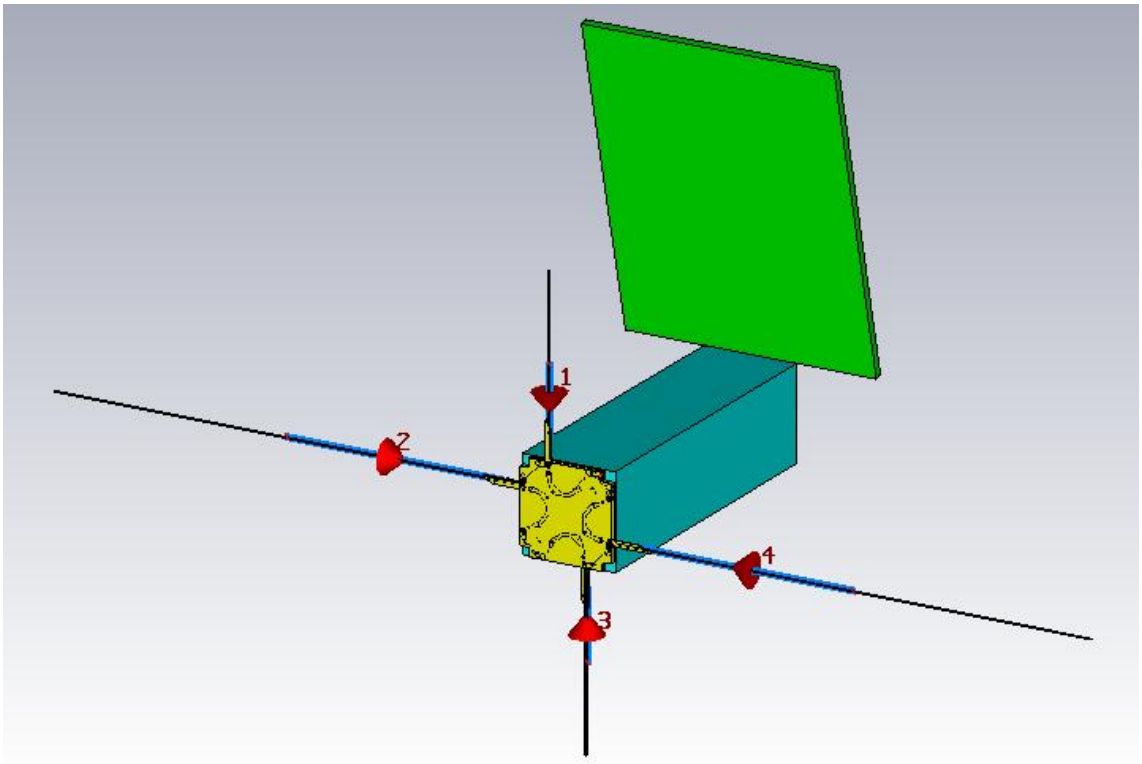

Figure 96. A3-Turnstile. ISARA UHF antenna CAD model.

A.3.3.1 Scattering Parameters (S – Parameters)

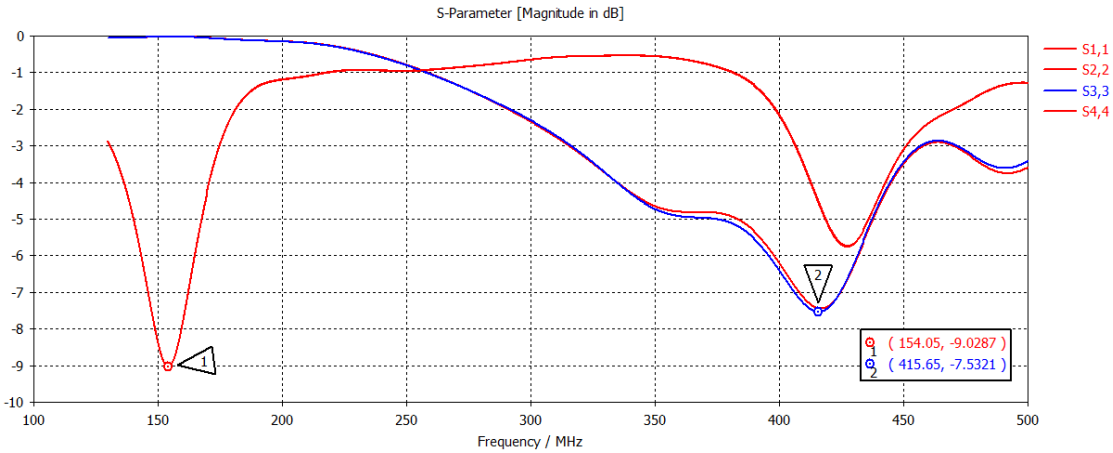

Figure 97. A3-Turnstile. Return loss.

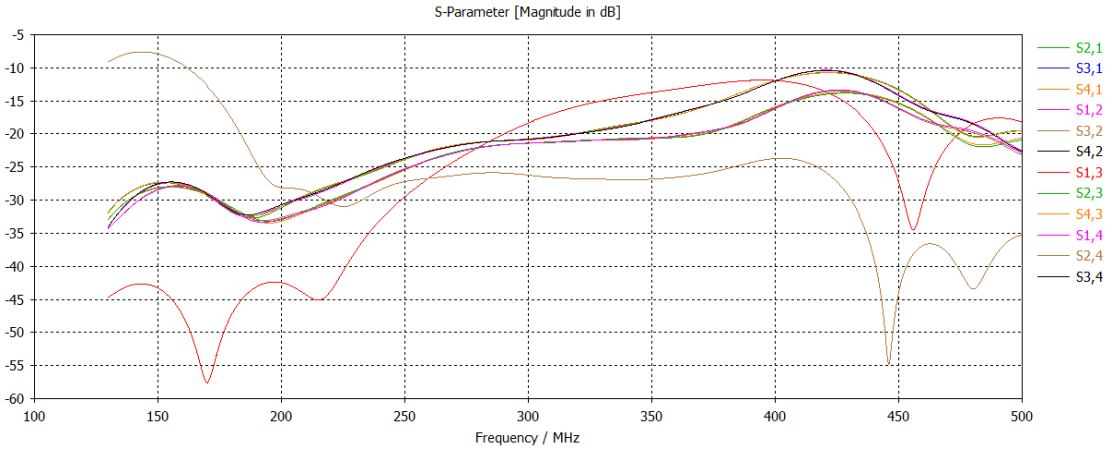

Figure 98. A3-Turnstile. Insertion loss.

A.3.3.2 Radiation Pattern

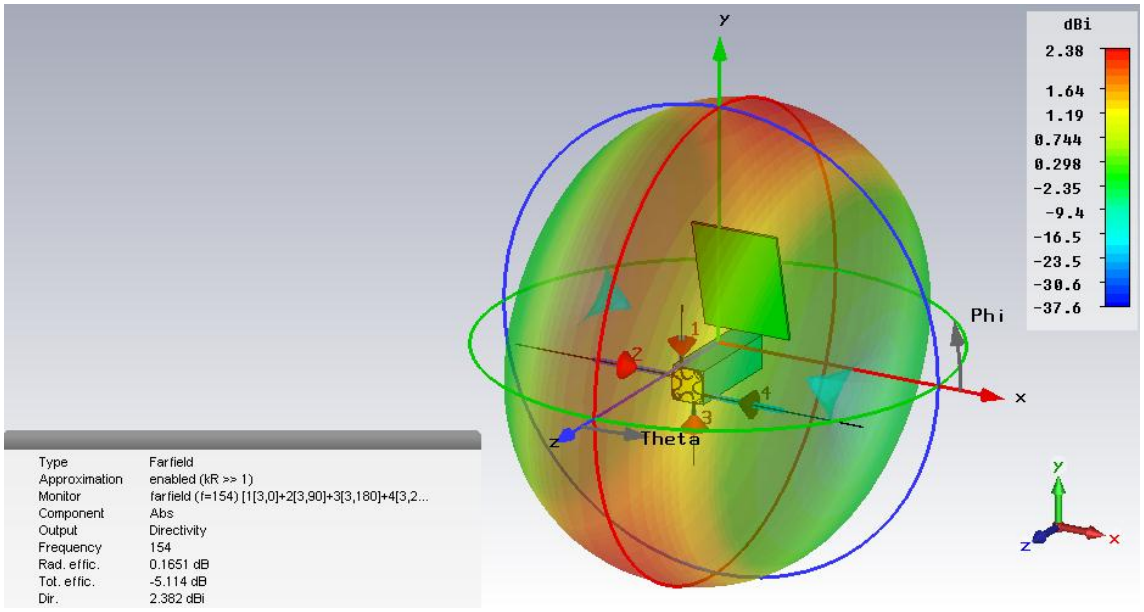

Figure 99. A3-Turnstile. 3D Directivity Radiation Pattern (154 MHz).

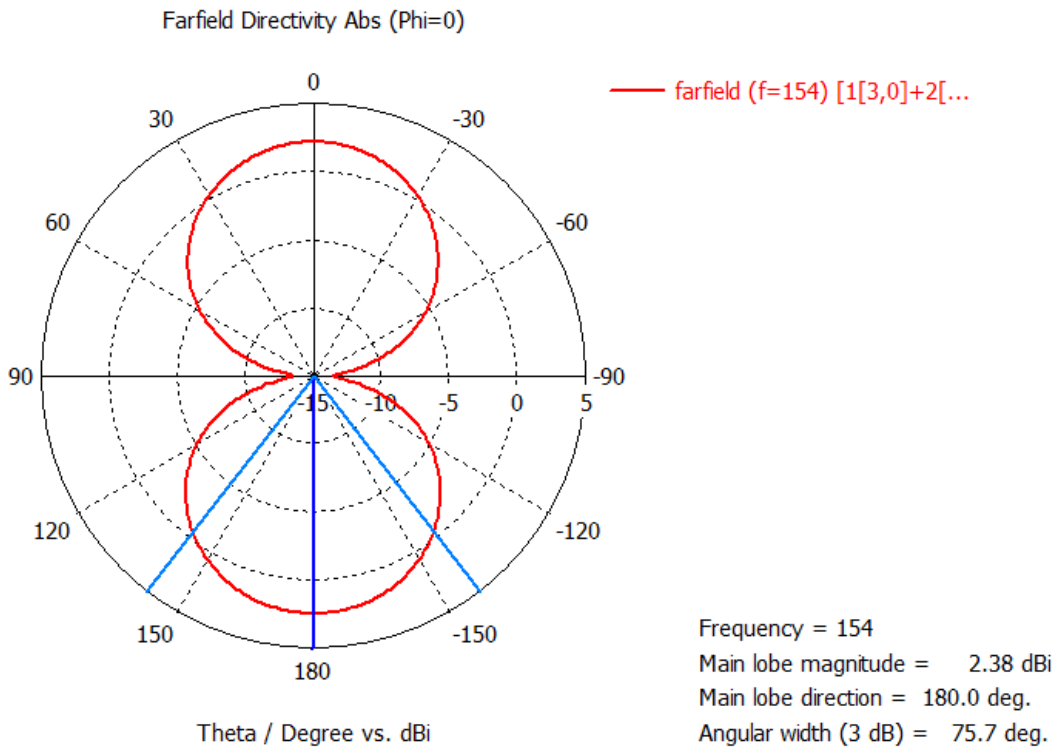

Figure 100. A3-Turnstile. Directivity Polar Diagram (154 MHz).

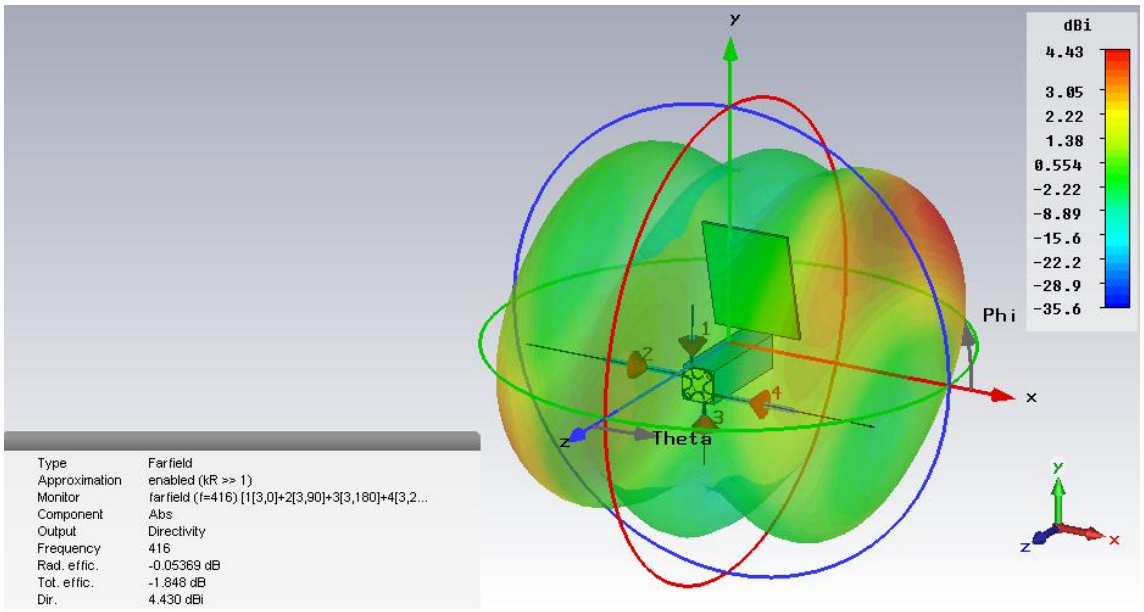

Figure 101. A3-Turnstile. 3D Directivity Pattern (416 MHz).

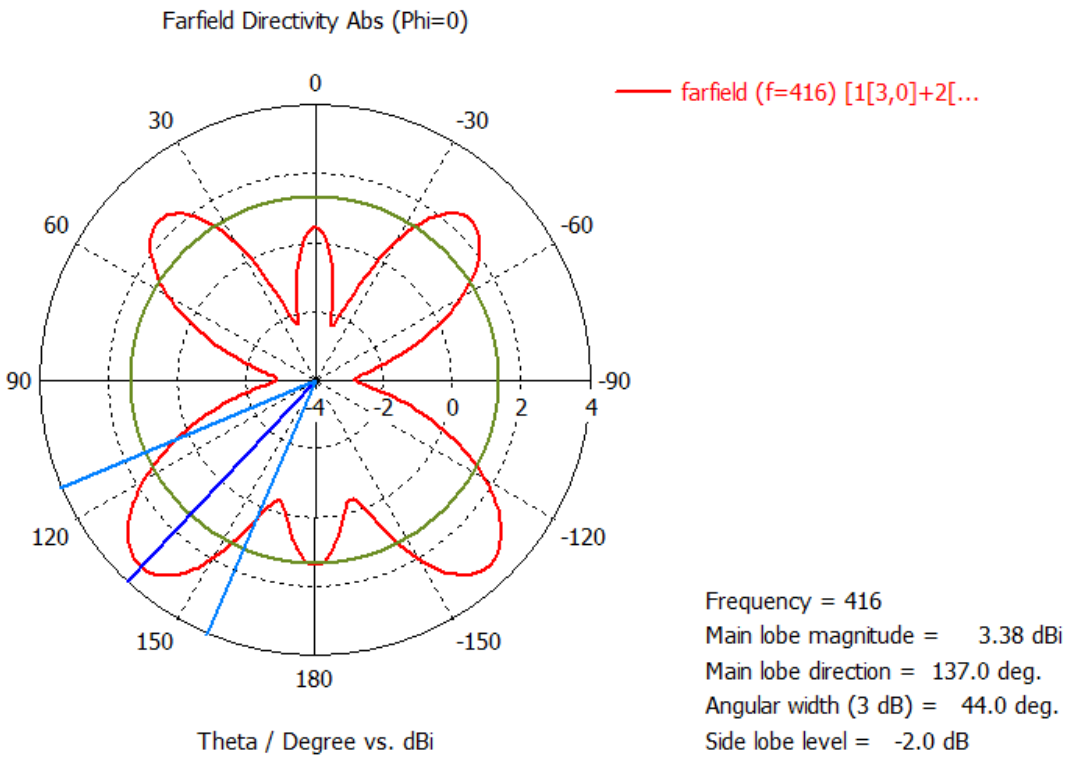

Figure 102. A3-Turnstile. Directivity Polar Diagram (416 MHz).

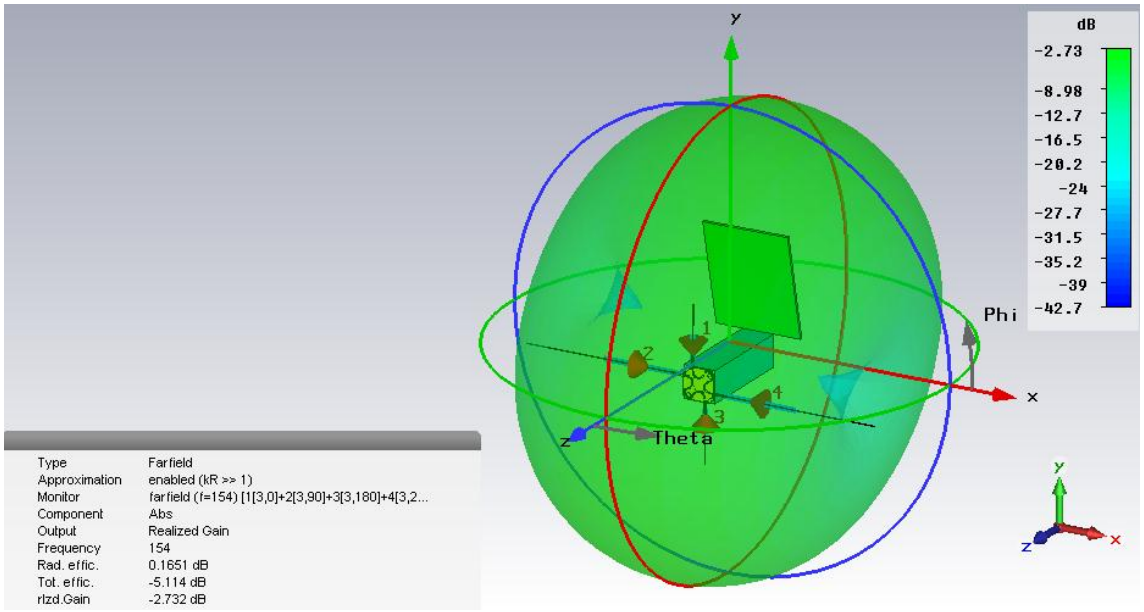

Figure 103. A3-Turnstile. 3D Realized Gain Pattern (154 MHz).

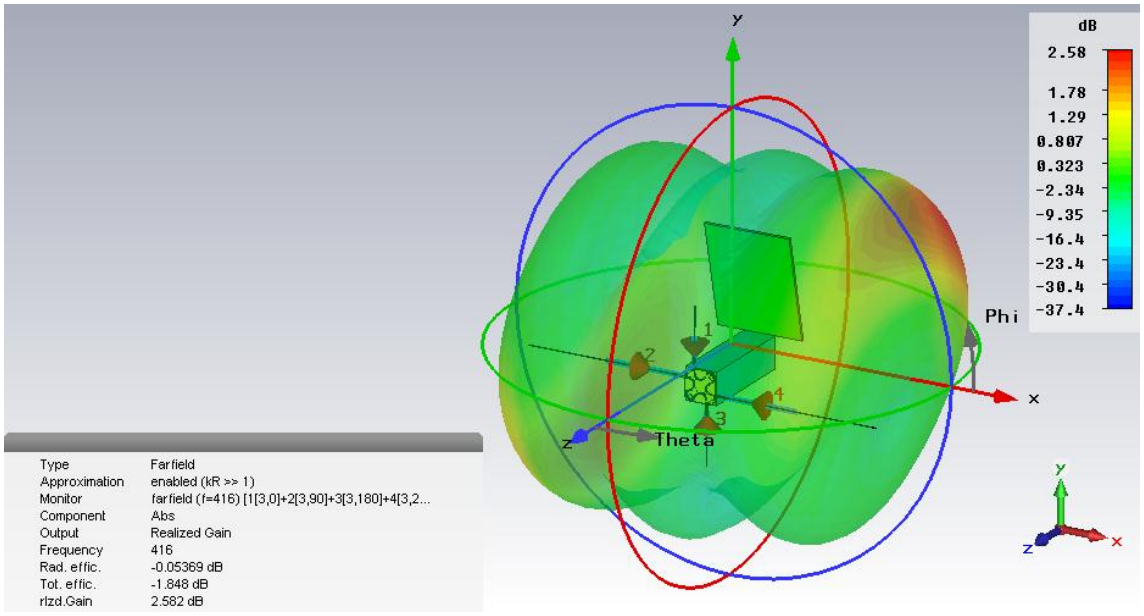

Figure 104. A3-Turnstile. 3D Realized Gain Pattern (416 MHz).

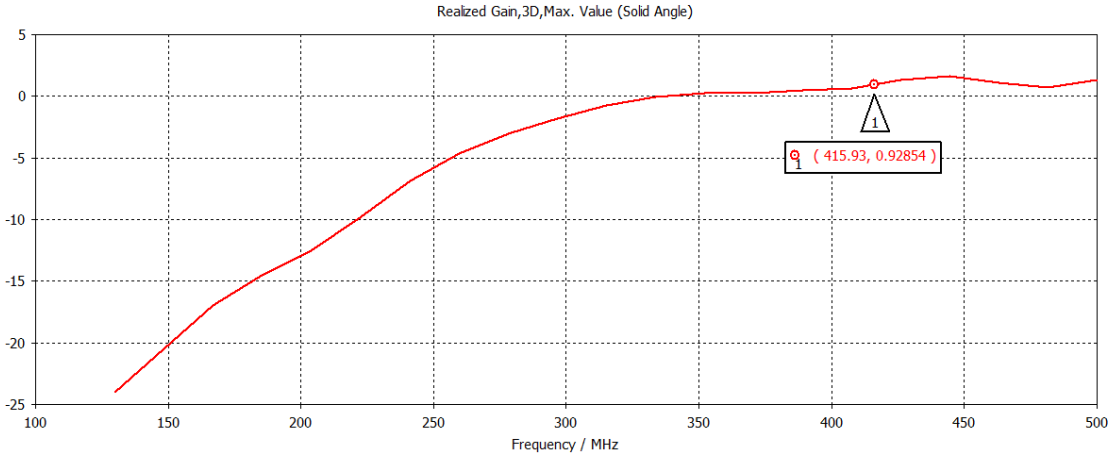

Figure 105. A3-Turnstile. Realized Gain dependent on range frequency 130-500 MHz. P1 and P3.

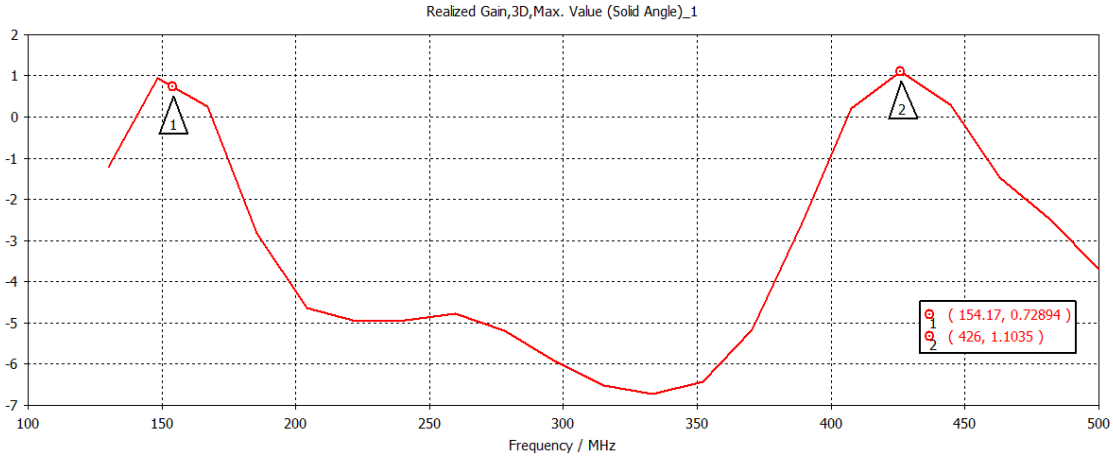

Figure 106. A3-Turnstile. Realized Gain dependent on range frequency 130-500 MHz.P2 and P4.

A.3.3.3 Efficiency

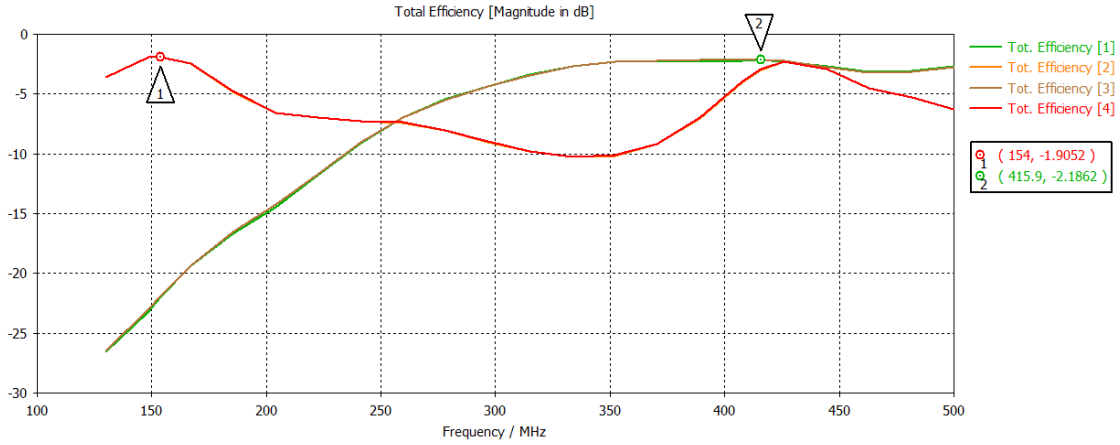

Figure 107. A3-Turnstile. Antenna efficiency dependent on range frequency 130-500 MHz.

A.3.3.4 Electric field

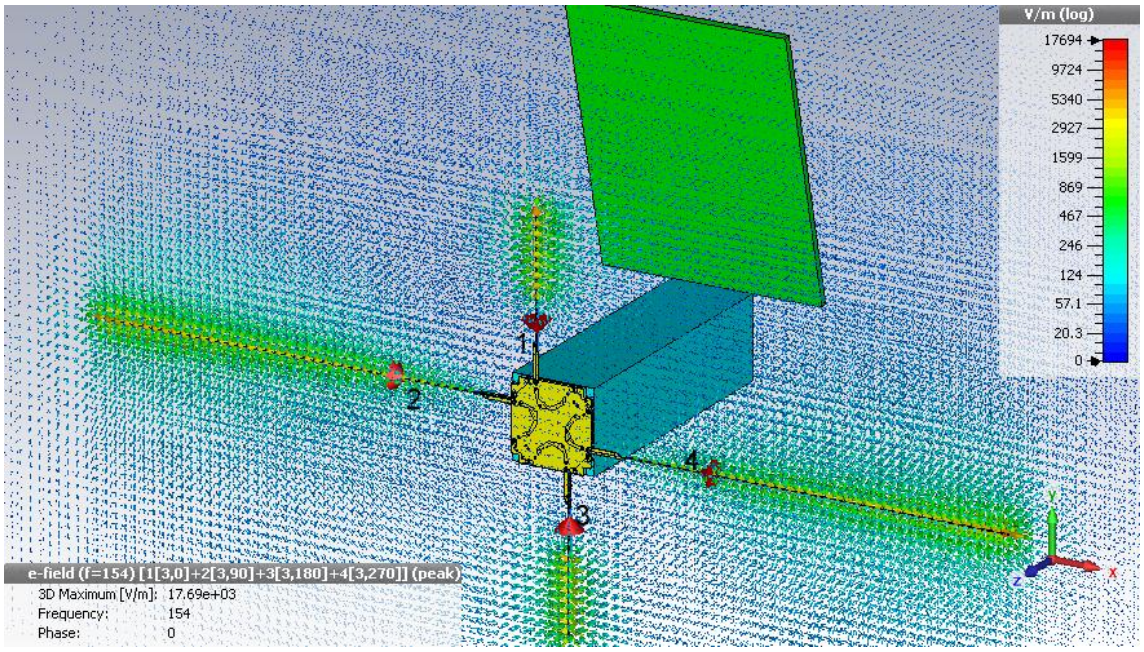

Figure 108. A3-Turnstile. Electric field (154 MHz).

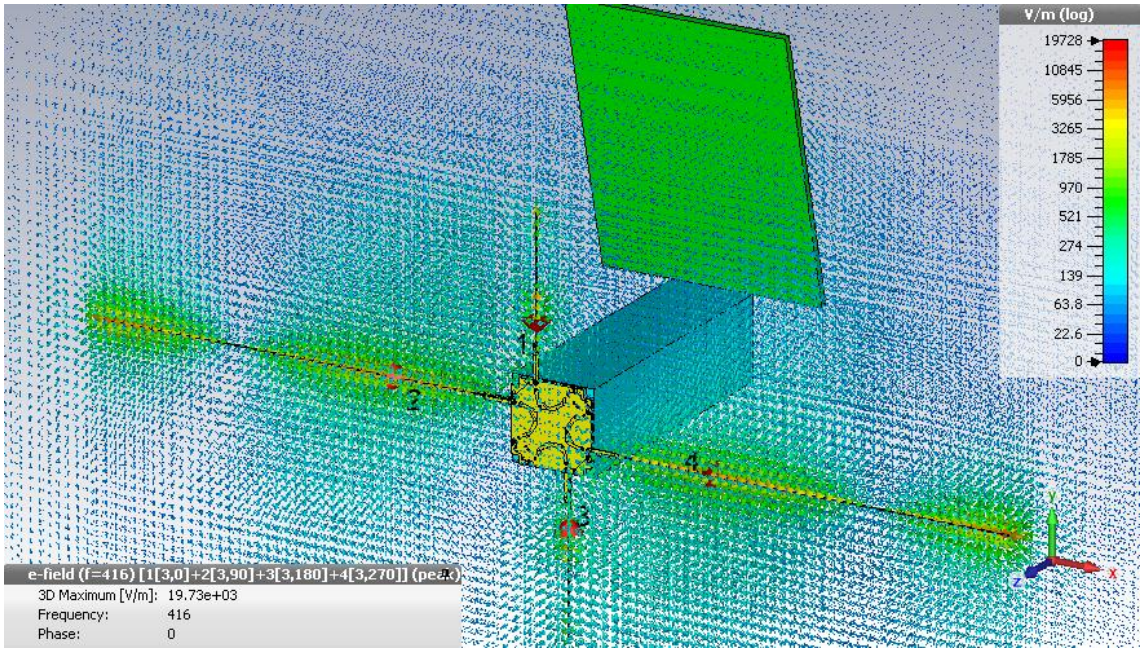

Figure 109. A3-Turnstile. Electric field (416 MHz).

A.3.3.5 Magnetic field

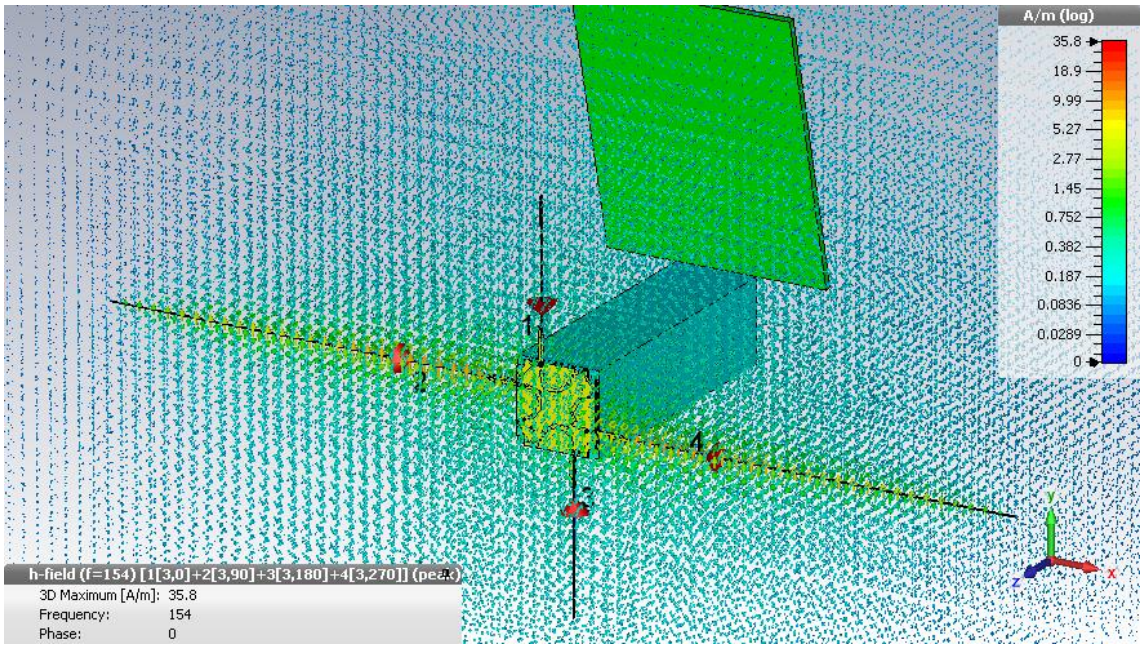

Figure 110. A3-Turnstile. Magnetic field (154 MHz).

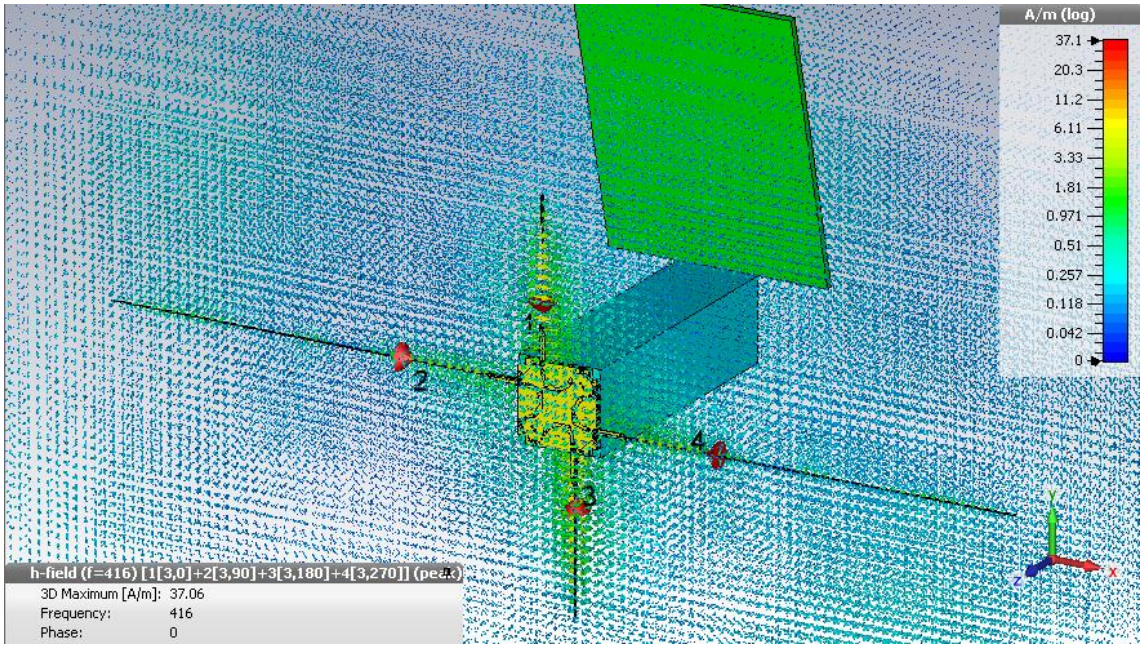

Figure 111. A3-Turnstile. Magnetic field (416 MHz).

B. ISIS WEBSITE RADIATION PATTERNS

B.1 3U UHF Monopole

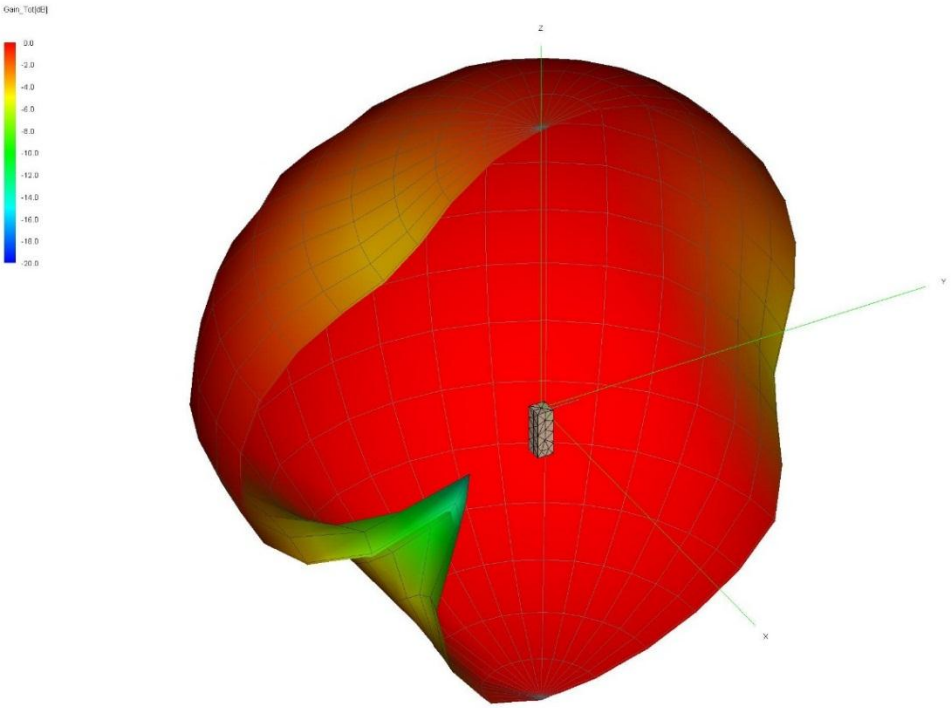

Figure 112. B1. 3D Gain Pattern.

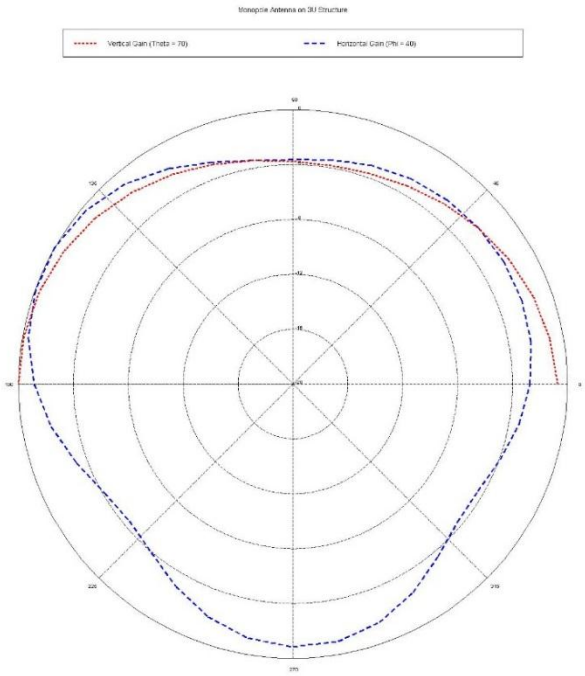

Figure 113. B1. Gain Polar Diagram.

B.2 3U UHF Dipole

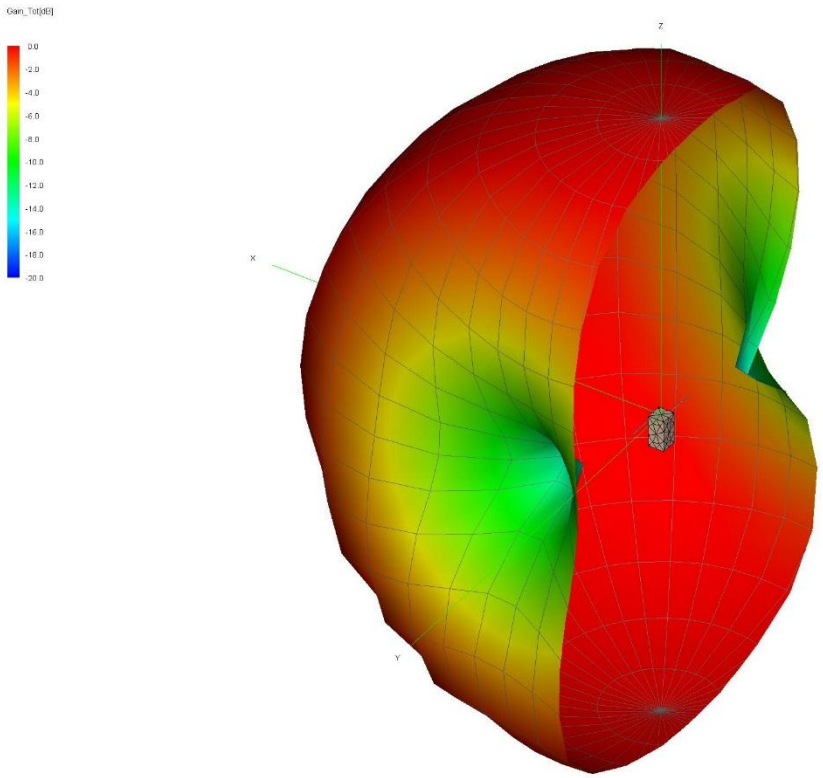

Figure 114. B2. 3D Gain Pattern.

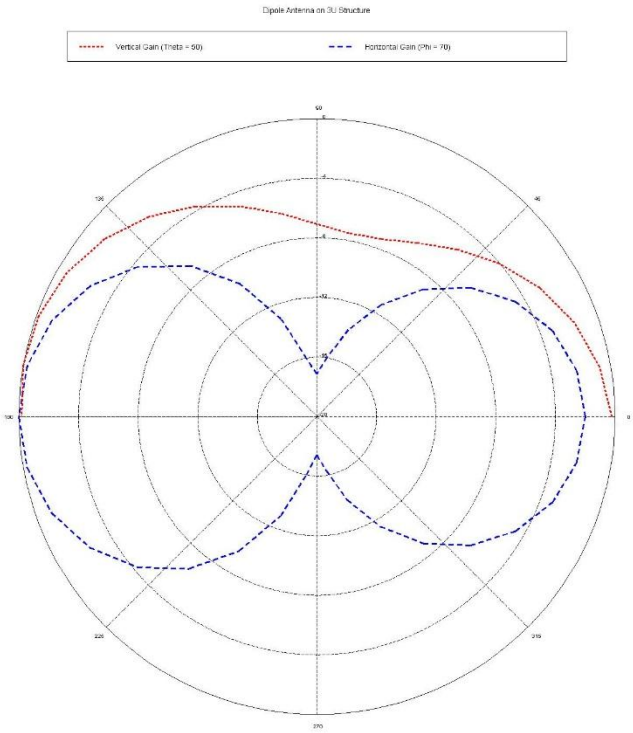

Figure 115. B2. Gain Polar Diagram.

B.3 3U UHF Turnstile

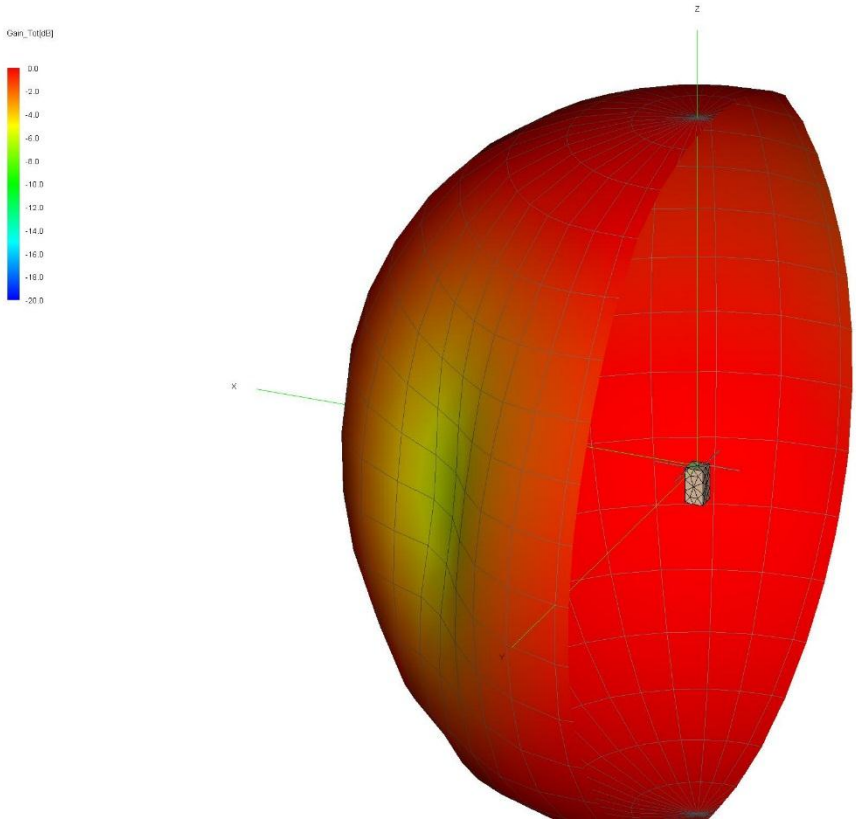

Figure 116. B3. 3D Gain Pattern.

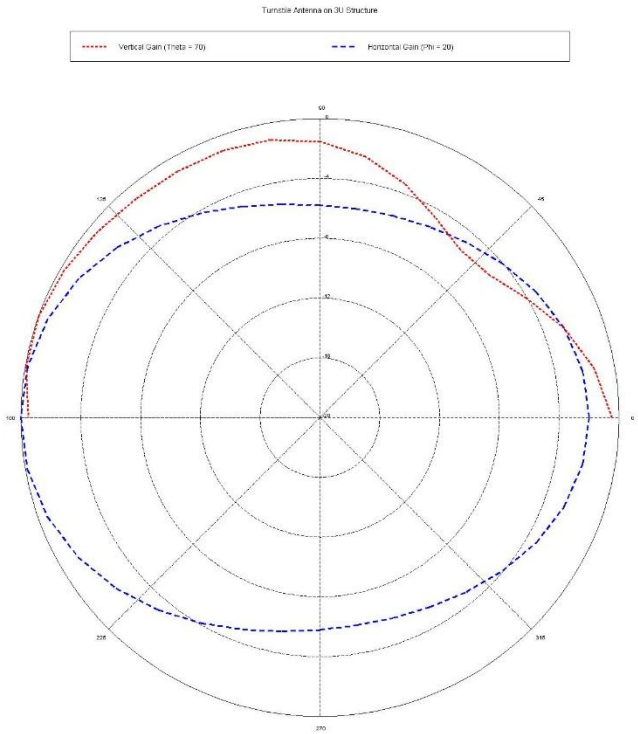

Figure 117. B3. Gain Polar Diagram.